# ECONOMIC CONTROL

*of*

# IRON AND STEEL WORKS

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*By*

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*With a Foreword by*

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# FOREWORD

The author has produced a very useful and practical manual on Economic Control, in which the problems involved are clearly stated, with solutions which in his wide experience he has found to be effective both in this country and on the Continent. His comparisons between Continental and British practice are valuable in that they stimulate a re-examination of our own methods. It is not necessary to agree with the author in all his criticisms and suggestions in order to find great value in the information which he has collated and presented in a logical form, the presentation of which, in a colloquial style, renders his discussion of the control of production, both technical and economic, easy of assimilation. He has the gift of thinking aloud, which is of considerable interest and advantage to the students of his subject. The necessity for those responsible for production and the technical direction of any works having knowledge of the financial results of their policy might be thought to be axiomatic, but far too often is it found that the accounting, commercial and production departments are so separate as to stand rather in a critical than in a co-operative relationship to each other. Indeed, it is sometimes held that this is their proper relationship and that it tends to the general efficiency of the organisation. I believe this to be entirely wrong, and I support the author's view that their relationship should be a complete understanding of each other's function and its bearing on the ultimate efficiency and prosperity of the organisation as a whole, and that therefore they should be fully co-operative in promoting the interests of the organisation of which each is only a part which cannot function without the others. This co-operation will undoubtedly be stimulated by a study of this book, and I commend it to the favourable consideration of all those already in or aspiring to executive positions in industry, whether technical, productive, commercial or financial. It would also form a useful text-book for a course of lectures on Economic Control of Iron and Steel Works, as it covers a field in which doubtless a great fund of knowledge

has been accumulated by individuals, very little of which, however, has so far been made generally accessible. Those training for managerial positions would certainly benefit by a study of this book. Universities and technical schools and colleges might include in their curricula, with great advantage, a course of lectures on the subject matter of this book, for degrees in Metallurgy and Engineering.

W. J. LARKE.

*Cray Hill,*
*Rectory Lane,*
*Sidcup, Kent.*

*September 22nd,* 1941.

# AUTHOR'S PREFACE

When discussing economic control in industrial works it can be assumed that in most cases those concerned have in mind only matters of accountancy and costing. There is no doubt that these are the main tools of economic control as explained in greater detail in the introduction to this book. It would, however, be an undue limitation of the first of these two notions, *i.e.*, " economic control " and " accountancy and costing," to consider them as almost identical.

" Economic control " means making sure that one of the main purposes of an industrial works, its profitableness, has been obtained in the most economic way, *i.e.*, to the highest possible degree with the lowest possible means. It is in fact the verification whether and how far the management of the works, this difficult compromise of the simultaneous balance between technical, commercial and psychological considerations, has solved its problems. It is clear from this definition that economic control must use beside the main tool of accountancy and costing any other method available to find out the actual state of affairs in the works on the one hand and to put at the management's disposal means of future improvement on the other hand.

It is the purpose of this book to discuss the individual parts of economic control and their connections with each other. It should be understood that only the point of view of considering economic control as an inseparable whole of technical, commercial, administrative and psychological questions can produce the favourable result, which should reasonably be expected from the necessary clerical apparatus.

The book deals with these problems from the point of view of the iron and steel industry, but the fundamental explanations can be considered as valid for industrial works generally. If the iron and steel industry is throughout quoted as example that is due to the fact that the author has been connected with this industry for 20 years and was able to draw comparisons between

German and English works which have shown—beside many differences—such a similarity of the main problems that the conclusions in both cases are the same in regard to principles.

The second purpose of the book is to contribute to a better understanding between the various groups of industrial employees engaged in the same works, but trained in different professions and working frequently not in the spirit of co-operation needed at present more urgently than at any time since the beginning of industrial activity. It is the conviction of the author that this co-operation cannot be brought about for long by compulsion, but can only be created and maintained if based on the mutual understanding of the various parties so essential to the success of their work.

Finally it seemed favourable to give an opportunity to British specialists to be more intimately acquainted with an important German publication [1] which reflects the present costing system as approved and almost ordered by the Government for the whole German iron and steel industry, and which can be considered as the counterpart of a publication of the British Iron and Steel Federation *Uniform Cost System.*[2]

The present book describes in five parts the whole sphere of economic control. The first part deals with "Accountancy" proper and its results, the balance sheet and profit and loss account; it explains the principle of book-keeping by double entry in so far as necessary for the understanding of this method, but not with the purpose of doing accountants' work.

The second part, "Works Accounts," covers the grouping of costs from various points of view. It gives the costing systems in the individual departments of a large iron and steel works, and discusses also material accounts and the organisation of stores and stocks as well as the forming, booking and controlling of wages. A section on the importance of work and time studies is included, and another on the costing problem in connection with by-products. It is this part that the intimate relations between problems of technical and commercial nature to those of administration, organisation, costing and psychology will become especially clear to the reader.

[1] K. KLEINE, H. KREIS, A. MÜLLER. "Leitfaden für das Rechnungswesen in der Eisenschaffenden Industrie" ("Guide for Industrial Accounts in Iron and Steel Works"), 1938, Verlag Stahleisen m. b. H., Dusseldorf.

[2] Published June, 1935.

The third part on "Job Accounts" deals with the development of general equations of costs and then discusses problems of evaluation explaining the contents of production and sales statements as made up in the manner usual at present.

In the fourth part, "Standard Costs," is shown how discussions on the influence of the activity factor on costs, on the calculation of the selling price and on the price-policy of the undertaking lead logically to the development of standard costs; and how they should be used in budgeting and estimating. The close connection between budgeting and planning is explained; thus again demonstrating that technical problems and those of organisation and cost-accountancy should not be dealt with independently. Of special importance should be the reference to the simplification of the whole cost-accountancy by correct and extensive use of standard costs wherever this can be justified.

Finally, in the fifth part, "The Organisation of Economic Control" is discussed, and the author indicates proposals for improvement based on his experience and logical conclusions.

As to the history and form of this book, the author wishes to add a few words. He had the opportunity of publishing in the last two years two series of articles, (1) in *Metallurgia* [1] on "Industrial Management and Production Control" and (2) in *Iron and Steel* [2] on "Features of Accountancy and Costing in Iron and Steel Works." These two series of articles, in which many readers have expressed interest, can be considered as the two foundation pillars on which this book has been built. Whole parts of these articles have been reprinted here, completely, where they seem to serve the purpose of this book.

It is the author's hope that this volume will prove of value to many people engaged in industry, especially in iron and steel works, whether they are engaged on the technical or commercial side; or whether they are working in research, production or trade. Even if they do not need for their daily work the special knowledge transmitted by this publication their understanding of the coherence of all that goes on around them will increase; and with that their willingness to follow the demands of a

[1] Published by The Kennedy Press, 21 Albion Street, Gaythorn, Manchester.
[2] Published by The Louis Cassier Co. Ltd., 22 Henrietta Street, London, W.C.2.

reasonable management which bases its measures on figures obtained by economic control.

There remains for me only the pleasant duty of thanking all who have assisted my work by advice and criticism. It is almost impossible to enumerate them, but I should like specially to mention two men, who have helped again and again and in such an unselfish manner that I feel greatly obliged to them: Mr. W. E. Benbow, the editor of *Iron and Steel*, and Mr. Chas. A. Otto, the editor of *Metallurgia*.

I cannot conclude without expressing my most sincere thanks to Sir William Larke, K.B.E., Director of the British Iron and Steel Federation, for his great kindness in writing a Foreword to this volume.

Where former publications of others or of myself are used, they are, of course, duly quoted as far as English literature is concerned, but German publications are not referred to in detail.[1]

I should, however, be only too glad to give advice in special cases to readers who wish to study the German literature concerned. I also would be grateful for any constructive criticism. Such personal contact with my readers would be the finest reward I could imagine for the work I have put into this book.

F. L. MEYENBERG.

LONDON,
*October*, 1941.

[1] It would be correct to make two exceptions from this rule, *i.e.*, to refer to the 160 or so reports of the Committee on Works-Economics of the "Verein deutscher Eisenhüttenleute" and to the publications of the Committee on Industrial Accounts of the "Verein deutscher Ingenieure." The author of this book was a member of both committees, and chairman of the second from its foundation till October, 1933.

# CONTENTS

PART THREE

## JOB ACCOUNTS

PART FOUR

## STANDARD COSTS



PART FIVE

## THE ORGANISATION OF ECONOMIC CONTROL

# INTRODUCTION

COSTING AND ACCOUNTANCY AS THE MAIN TOOL OF ECONOMIC CONTROL

## A. THE POSITION OF COSTING AND ACCOUNTANCY IN AN INDUSTRIAL UNDERTAKING

WHEN technicians of any kind, who have succeeded to higher positions in industrial management, meet, say, at the annual meeting of some scientific or technical institution, it is not unusual, when conversation has become more intimate, for them to lament the fact that their work is no longer technical, that this " confounded administrative activity " takes all their time, and that they have to leave all—or at least nearly all—the interesting problems, the solution of which has been the main object of their training, to their subordinates. Who can doubt, if he has himself been in such a position, that these complaints are well-founded ? But who can also deny that the greater part of the so often abused " administrative activity " consists in smoothing over disagreements between the leading persons of the firm, in positions just under the general manager or managing director ? One of the " big men " of the industry in the U.S.A. once said that that part of his job took at least 80% of his time. And it is only too well known, that differences of opinion between two departmental managers tend to infect all their respective subordinates and thus increase the damage to the firm more and more if a compromise is not found at the right moment.

How can this state of affairs, which seems so foolish to any outsider, be explained, since the personal welfare of all executives depends on the prosperity of the firm, to which they themselves do harm again and again ? If we leave out the cases of ill-will and bad character, which in the author's experience are rare, if not entirely non-existent, it is the differences in education and training, the upbringing with ideas of different origin and with different

aims, which make understanding between man and man so difficult and sometimes even impossible. Therefore we find that these conflicts of opinion occur most frequently between members of the technical and the commercial sides of the undertaking, and the clashes take place mostly over administrative matters, where both sides come into close touch.

Now it is a common experience that to have found the reason of an inconvenience is to have nearly overcome it. Why not take the second step, *i.e.*, fill in the gap in the training of both sides so that a better understanding is possible ? This book is intended as a contribution to that end.

No one with experience of conditions in practice can deny that the technician in iron and steel works—he may be metallurgist or engineer—usually does not know enough about the main tool of economic control, *i.e.*, accountancy and costing, to realise, on the one hand, how far he has to help his colleague on the commercial side, or what aid he can expect and should ask from him, on the other hand. Moreover by taking an interest in these problems the technician who is otherwise only dealing with material and men, will learn to think from an economic point of view not in the haphazard way in which nearly everybody imagines he understands economics, but basing his thinking on actual figures and the comprehension of cause and effect.

On the other hand, the accountant and costing man cannot be acquitted of his share of guilt that often so little understanding prevails between the two sides ; here the author hopes to be specially adapted for interpretation. He is, of course, no professional accountant, but one who has been engaged in accountancy and costing work in various positions for many years : as he is an engineer he perhaps understands the mind of the technicians better than an accountant, and has therefore chosen a method of presentation which may deviate in some degree from that of orthodox English accountancy. This, it is hoped, may lead accountants to constructive criticism ; for that would completely coincide with the reason for this book, *i.e.*, to bring about a better understanding between the two opposing camps.

It is also hoped that accountants will be interested by a form of presentation, which differs from that which the British Iron and Steel Federation has chosen, since this book follows more the lines of the German publication mentioned in the preface.

This has been done not because that publication is considered superior to the English one, but because of its suitability for the special purpose of this book, which is concerned more with a broad survey than with the many details so important in actual practice.

* * *

Now let us go back to the two questions mentioned above and to their answer; they may be considered at the same time as the most appropriate indication of the spirit in which this book is written:

(1) *How far should a technician, employed in the iron and steel industry, be acquainted with accountancy and costing?*

Obviously his knowledge should not be so detailed as that of an accountant; for nobody expects that he will ever do the job of an accountant; but he should understand the main principles, since there is no better way of learning to think from the economic standpoint than, for example, to follow up the comparison of two different methods of production in actual figures, or to find out the savings to be effected by a proposed new plant, as compared with the existing one. The technician, who is trained at the university or in his early positions in the works, to observe the metallurgical or purely technical processes alone and to think in terms of qualities, quantities and times, forgets too easily that behind these measures is nearly always hidden another, money, which will and must decide ultimately whether his work can be called successful or not.

The technician should not be blamed for that oversight; for it is no secret that this part of his education is frequently neglected at the university or the technical college, sometimes intentionally, on the ground that it is impossible in the theoretical lectures to give the correct impression of work in practice, and that life alone will provide the new-comer with the necessary lessons. Do the adherents to this view not understand that the same argument could be brought forward against any kind of academic education? The author's experience has shown that it has only too often been the incapacity to understand what thinking economically means, that has led to that attitude. Be that as it may, most technicians initially show a lack of this type of mind, and it is the more difficult to overcome this deficiency, since thinking economically differs *in principle* from that necessary in

the purely technical sphere. For example, no longer are there laws of nature, correct and absolute in themselves; everything depends on fluctuating relations between different classes of human beings; the measure itself, money, is not a completely stabilised value. A changed outlook on life is indeed necessary when processes, which previously were only of technical interest, have henceforth to be considered from an economic point of view. That is indeed the main preoccupation of a technician when approaching matters of accountancy and costing.

There are, however, other reasons, which may be to some people even more obvious than that which has been put first, because it is considered as the most important. In an industrial undertaking, even if the organisation is not first class, there appear from time to time on the desk of a technician in a superior position, costing reports which reflect—or at least should reflect—the economic result of his work. It is a part of his duty to understand these reports, to criticise them, sometimes to discuss them with his accountant-colleagues; perhaps he wants additions or changes, not of the figures, but of the form of presentation; he must be in a position to find out whether a refusal of his request is based on difficulties inherent in the matter itself or is due to indolence or even ill will. For these discussions he needs a knowledge of the work done in the costing department, a general idea of the costing system used in the works; he must understand the special language used by the cost accountant so that he can follow the latter's explanations of points which are not clear to him. He needs all that to understand what information he has to give to the cost accountant and why; and where he would be justified in refusing information because its preparation would be too difficult, too costly, etc. How many annoying discussions or even personal ill-feeling could be avoided, if the technician could always follow the train of ideas of his colleagues instead of, aloud or *sotto voce*, giving vent to his anger about the "unnecessary scraps of paper" and about the "counting and weighing of things which will not be lost even if these measures are not taken," etc. Everybody in practice has heard such utterances often enough, and thus these remarks will be sufficient.

Now, consider the second question:

(2) *What can and should be expected from the accountant and costing man for purposes of economic control?*

Just as we had to deplore a lack of understanding of the cost accountant's job by the technician, so very often the needs of production and sales are not given sufficient consideration by the accountant.

There can be no doubt that, from the point of view of the undertaking as a whole, production and sales come first, and accountancy and costing can only be considered as services to the production and sales departments, very useful and necessary services indeed, but in all circumstances of less importance than the production and the sales.

Hence, no measure adopted for accountancy or costing purposes should be of such a nature that the work of the production or sales department is hindered more than is absolutely necessary. It is the manager in charge of production who alone can decide whether there is any undue hindrance, for he not only knows best the needs of the production department and the mentality of the men engaged therein, but is also responsible for the result of the production and it would not be fair to burden his shoulders with such a responsibility, without letting him have a free hand in his sphere as far as possible, and the same applies to the sales department.

The second demand is that accountancy and costing should give the technician all the figures necessary for economic control, correctly, quickly and in the most useful form. Again it must be pointed out that the production or sales man's opinion should be the decisive one ; for they use these figures first and for the most important purpose, *i.e.*, controlling and improving the production and sales. It is, therefore, only a question of professional skill to adapt the needs of accountancy, costing, etc., to the personal requirements or peculiarities of the production or sales man, as far as that is compatible with demands from the other, *i.e.*, the side of accountancy.

The third demand is that the structure of accountancy and costing in the undertaking should be co-ordinated and comprehensive, *i.e.*, so that no contradictory or repeated enquiries can be directed to the people engaged in production or sales. This will facilitate the understanding of the figures and results of the costing department, which should not—as it is unfortunately sometimes the case—be considered as secrets or the property of that department alone, but rather the contribution of the depart-

ment to the prosperity of the whole undertaking, and consequently a guide to all concerned.

## B. THE STRUCTURE OF COSTING AND ACCOUNTANCY

Considering the state of affairs as indicated by the demands of the production and sales men, the author has come to the conclusion that they all can best—and perhaps alone—be fulfilled if the system of accountancy and costing in an industrial undertaking is considered as a complete whole. This whole may consist of several sections, but they should not have, in the same undertaking, an independent existence ; they should not arrive at different results when considering the same matter. They should indeed have such close connections that any differences between their results can, and should, always be proved and explained, thus testifying to their correctness just by those differences. This opinion is not shared by all experts, some of whom erect a barrier between accountancy and costing. The author answers that he agrees that both use different methods, but that his experience has shown the usefulness of the view expressed above, as far as the purposes and the results of accountancy and costing are concerned ; it must be left to the reader to decide which opinion he will adopt.

The structure of industrial accountancy and costing, which may perhaps be called briefly " industrial accounts," is illustrated by Fig. 1. Of course, this does not cover all possible cases as they may occur in industry, and for some applications it may be too detailed, especially in the case of comparatively small firms ; but that does not matter for our purpose, which is to obtain a clear and simple survey of that sphere in industrial life. Fig. 1 also indicates the main relations of the individual sections to such fundamental questions as : Do the figures of the section in question belong to the past or to the future ? Do they refer to a period of time either for the undertaking as a whole or for the production alone, or do they give the output ? No further explanation seems to be necessary especially as the reader will become more familiar with the details of this Fig. 1 as the book progresses.

Sometimes it is concluded from the fact that the "industrial accounts" as illustrated by Fig. 1 form a coherent whole, that the whole sphere should be under one man, directly responsible to the general manager of the undertaking. No doubt this would be an ideal solution from the theoretical point of view; but experience has shown that problems of organisation cannot be dealt with in practice without considering all the various working conditions which generally make it impossible to do what may be ideal in theory. In particular the question arises whether there is a man available having not only the necessary knowledge and experience of the whole domain of "industrial accounts," but also strength of character to overcome contrasting opinions without friction and to obtain the necessary co-operation from all quarters. Therefore we had better disregard this question of organisation for the time being and limit our considerations to the subject of industrial accounts itself.

# PART I

# ACCOUNTANCY

## CHAPTER I

# THE ESSENCE OF ACCOUNTANCY

THE backbone of industrial accounts is certainly the part called "accountancy," *i.e.*, that part which is concerned, as shown in Fig. 1, with the figures of the past of the undertaking as a whole related to a time basis—week, month, year, etc. This is also the part in which the method of book-keeping by double entry is universally used. Everyone who has to deal in his work with economic problems should realise that some knowledge of this method and of "accountancy" is absolutely necessary, if he is to understand what the effect of his work actually is; how the financial basis of the undertaking is built up, and how it changes under changing working conditions. It is strange in these circumstances that accountancy is often regarded in technical circles with aversion mingled with fear. Again and again the author has encountered this attitude often veiled behind the objection that the speaker could imagine nothing more dull than accountancy. And yet no less a personality than Goethe said that book-keeping by double entry was one of the most wonderful inventions of the human mind. How can these contradictions be explained? It is nearly always the case that the man who criticises accountancy unfavourably has not the slightest idea of what it means. At best he has started to study one of the usual handbooks written by professionals for those who are already in the profession, and has put it aside because he cannot understand the language. It cannot be denied that these books are often written in a difficult language, as if the author wanted to keep his topic as a kind of "secret science." And yet, any real expert will admit that the great value of accountancy as of most great inventions, lies in its simplicity and clearness.

It is therefore not superfluous to explain some general principles of accountancy, before any special details for iron and steel works are dealt with. It must, however, be remembered that a complete description of accountancy cannot and shall not be given in this

book. The intention is to explain some of the main features so far as they should be understood by any industrial employee.

* * * * *

Accountancy is the logical representation of the financial condition of an economic undertaking and of the changes in that condition, so far as they can be evaluated in money.

The original form of capital is ready money ; this is changed *via* raw material, wages and general costs into goods, the sale of which again brings ready money into the undertaking, normally in a greater amount than there was originally.

Accountancy should reflect this flow of capital at once and correctly, and it should particularly show whether the expenses incurred by the undertaking are completely transformed into goods or are used for building new, or enlarging existing plants. The more accurately the movements of capital are reflected the better is the purpose of accountancy achieved. Its statements should provide, at least for the expert, a complete picture of the course of business transactions and the state of affairs at any given time.

## CHAPTER II

# THE INSTRUMENTS OF ACCOUNTANCY

ACCOUNTANCY obtains these results gradually: the first step is to record each individual business transaction in one of the fundamental books. Such "books," in the proper sense of the word, *i.e.*, in the old form in which they were used for centuries, have, of course, almost completely disappeared. Modern duplicating procedures have replaced them, but this is only a change in the form; the nature of the procedure is not altered. It seems better for the purpose of this description, *i.e.*, the explanation of principles, to use the old form. As soon as these principles are clear, the transition to any modern form will not be difficult to understand. Moreover, this method of description emphasises the point that all these modern forms of book-keeping, to which so-called "organisers" attach exaggerated importance, are mere externals, which do not touch the essence of the problem.

The sequence of the business transactions in these books is primarily according to time; they are not arranged according to their nature. This second arrangement is, however, already indicated by making a note against each entry indicating what part of the property or what kind of business transaction is affected, *i.e.*, to which accounts the entries must afterwards be transferred. This separation can be effected to some extent by the direct use of various books, *e.g.*, the cash book, the purchase book, the sales book, etc., but again this is no essential feature of this system.

The second step is to transfer the figures of the individual business transactions to a second book, the ledger, which is not arranged according to time, but in which the nature of the individual transactions is the governing factor, and which is, therefore, subdivided into "accounts."

## A. ACCOUNTS

**1. Accounts Generally.** An account is the continuous representation of the state of one and the same part of the assets

or liabilities of the industrial undertaking, showing clearly its increase and decrease in the course of time.

It is of the utmost importance that the accounts are selected not only according to the nature of the undertaking—which is fairly obvious—but also according to the various uses made of the accounts by all parts of the works, especially by the production and the sales departments. Before definitely fixing every detail, the list of accounts should therefore be submitted to those who are responsible for the main sections of the works, and whose activities are afterwards controlled by the accounts, as they alone can be so familiar with all the items necessary for real control as to ensure that nothing necessary is forgotten and nothing superfluous included. Of course, they can only act as consultants; the final decision remains with the accountant, who is responsible for the results of the industrial accounts as a whole.

$d$ = sum of the debit side.
$c$ = sum of the credit side.
$b$ = balance.

| (1) $d > c$ | | (2) $c > d$ | |
|---|---|---|---|
| $d$ | $c$<br>$b$ | $d$<br>$b$ | $c$ |
| $d$ | $c + b$ | $d + b$ | $c$ |

FIG. 2. Balancing of an account.

The form of an account, with its debit side and credit side, is so well known generally that no further explanation seems to be necessary; and yet the technician, accustomed to other methods of calculation, often has difficulty in working with accounts. Here everybody is restricted to addition only—subtraction not being allowed—and in consequence the balance (it may be profit or loss) is always shown on the side with the lower total, *i.e.*, the credit balance on the debit side and the debit balance on the credit side. It is, so to speak, as if the accountant knows of the equations $d = c + b$ and $d + b = c$ (see Fig. 2), but does not realise that they can be written also in the form

$$d - c = b \text{ and } c - d = b,$$

a fact which we can also observe in daily life. When we are

shopping and receiving the change, the shop assistant always calculates by addition.

It may be further remarked that the name of the method, "book-keeping by double entry," indicates that no one single entry is permitted : if an entry has to be made on the debit side of one account, a second entry of the same figure *must* be made on the credit side of another account, and *vice versa.* The rigorous control from an arithmetical point of view, which is so significant of this method, is based on this rule.

**2. Accounts of Different Kind.** Speaking generally of accounts we may distinguish three different kinds :—

(1) Stock accounts, showing the change of quantities of materials by receipt and delivery.

(2) Expenditure accounts, showing the spending of means of payment for various purposes.

(3) Result accounts showing profit or loss when carrying out some business transaction.

Formerly it was quite common not to separate strictly these different kinds of accounts, *e.g.*, accounts of the first and third kinds were mixed and perhaps sometimes called "working accounts." This should be avoided as far as possible. Why, is best explained by an example.

A special product was in stock at the beginning of a period in a quantity of 1,000 pieces at a cost price of £10 per piece. During the period 500 pieces were produced at the same unit cost and 700 pieces were sold at £13 per piece. These transactions were booked in the same account, thus :

| | | | |
|---|---|---|---|
| (1,000 × £10 =) | £10,000 | (700 × £13 =) | £9,100 |
| (500 × £10 =) | 5,000 | balance | 5,900 |
| | £15,000 | | £15,000 |

What is the balance ? Obviously it is a mixture of two completely different things :

(*a*) There are (1,000 + 500 − 700) = 800 pieces at £10 = £8,000 in stock.

(*b*) There is a profit of 700 × (£13 − 10) = £2,100 by selling at £13 per piece, 700 pieces, which have entailed costs of £10 per piece. Therefore the balance of the account is £8,000 − £2,100 = £5,900, *i.e.*, the difference between the cost of 800 pieces and the

profit obtained by selling 700 pieces. That, however, cannot be seen from the account in the ledger, which shows neither the quantities, nor the unit prices (shown above at the account in brackets) but only the money sums. The correct booking should be done in two different accounts as follows :

STOCK ACCOUNT

| | | | |
|---|---|---|---|
| (1,000 × £10 =) | £10,000 | (700 × £10 =) | £7,000 |
| (500 × £10 =) | 5,000 | Balance | 8,000 |
| | £15,000 | | £15,000 |

RESULT ACCOUNT

| | | | |
|---|---|---|---|
| (700 × £10 =) | £7,000 | (700 × £13 =) | £9,100 |
| Balance | 2,100 | | |
| | £9,100 | | £9,100 |

**3. Accounts and Types of Costs Almost Identical.** Another point to which attention may be drawn is that the accounts should be selected so that as far as possible there is always only one account in which an individual transaction can be booked. This can best be effected if (*a*) it is borne in mind that costs can be classified from two different points of view, according either to the various types which they represent, or to the various positions in the works where they arise, and (*b*) if only the first of these two view-points is used in fixing the list of accounts ; in other words, if the two expressions " accounts " and " types of costs " are considered as almost identical. Again this may be explained by an example.

The packing of the finished goods may be done in a special packing department of the factory. The packing costs are composed of the costs of the packing material, the wages of the packers and the overheads of this department. As a material account and a wages account exist (material costs and wages being types of costs) a packing account should be avoided. If not, the correct booking would be :—

(1) For the packing material on the material account and for the wages on the wages account, and :

(2) A transfer in both cases to the packing account. This,

however, in spite of the complicated booking, would not show the total packing costs, because the transfer of the overheads—themselves composed of many various types of cost—from the corresponding accounts to the packing account causes so much difficulty that it is usually omitted completely or at least not carried out to the full extent. Similar examples are given by the maintenance account, the internal traffic account, etc.

This criticism, however, does not mean that there is no way of finding out the actual packing, maintenance, or internal transport costs; on the contrary it will be seen in the course of these discussions that a correct collection of these costs can be obtained easily in another way, *i.e.*, the "statistical method" of cost distribution to positions of costs, instead of the double entry method of cost distribution to types of costs or accounts. It is not meant by this that the latter method is impossible; it is only more complicated than the former and therefore too expensive and more difficult to understand.

There may be also cases in practice where this latter method cannot be avoided; but in any case it is a good help for the beginner in accountancy to have a clear understanding of the conditions involved.

**4. The "Work in Production Account."** There may further be mentioned a method of splitting the account "work in production"—or as it is sometimes called, "work in progress"—which has been found very useful for control purposes. The "work in production account" represents the half-finished goods, and its value is obviously changing continuously as production goes on, but at any moment this value is composed of that of the raw material used, the productive wages already paid, and the corresponding overheads. It is usual to charge these three parts of the value to a common account, *i.e.*, "work in production," and to discharge this account correspondingly as soon as some half-finished goods have been completed and transferred to the stock of finished goods.

The author has found it very useful to keep the three parts separated, as long as the work is still really in production, and to substitute the account "work in production" by three others: "material in production," "wages in production" and "overheads in production," and even to add a fourth "percentages of wages in production."

The booking on these four accounts is illustrated by Fig. 3.

MATERIAL IN PRODUCTION

| | | | |
|---|---|---|---|
| Brought forward from last period .. .. .. | 400 | Material contained in finished goods .. .. | 300 |
| New material during the current month .. .. | 350 | Material at end of current period .. .. .. | 450 |
| | 750 | | 750 |

WAGES IN PRODUCTION

| | | | |
|---|---|---|---|
| Brought forward from last period .. .. .. | 1,200 | Wages contained in finished goods .. .. | 900 |
| Wages paid during current period .. .. .. | 1,000 | Wages at end of current period .. .. .. | 1,300 |
| | 2,200 | | 2,200 |

OVERHEADS IN PRODUCTION

| | | | |
|---|---|---|---|
| Brought forward from last period .. .. .. | — | Percentage estimated corresponding to the wages paid during current period 150% of 1,000 = | 1,500 |
| Expended during current period .. .. .. | 1,450 | | |
| Overheads surplus, *i.e.*, over-estimation percentage of wages .. .. | 50 | | |
| | 1,500 | | 1,500 |

PERCENTAGE OF WAGES IN PRODUCTION

| | | | |
|---|---|---|---|
| Brought forward from last period .. .. .. | 1,800 | Percentage contained in finished goods 150% of 900 .. .. .. | 1,350 |
| Percentages added during current period .. .. | 1,500 | Percentage still in production at end of the current period .. .. .. | 1,950 |
| | 3,300 | | 3,300 |

FIG. 3. "Work in Production" Accounts.

It is assumed that at the beginning of a certain period, *e.g.*, a week, there was in production, *i.e.*, on hand in the works in the form of semi-finished products :—

| | |
|---|---|
| Material to the value of .. .. .. | £400 |
| Charged by wages of .. .. .. | £1,200 |
| And by overheads of .. .. .. | £1,800 |

New work entered production during the period in the form of :—

| | |
|---|---|
| Material .. .. .. .. | £350 |
| Wages .. .. .. .. .. | £1,000 |
| Overheads .. .. .. .. | £1,450 |

Finished goods went from production to stock, represented by :—

| | |
|---|---|
| Material .. .. .. .. | £300 |
| Wages .. .. .. .. .. | £900 |
| Overheads .. .. .. .. | £1,350 |

Obviously there should remain in production at the end of the period :—

| | |
|---|---|
| Material .. .. .. .. | £450 |
| Wages .. .. .. .. .. | £1,300 |
| Overheads .. .. .. .. | £1,900 |

But as the correct percentage during this period,

$$i.e., \frac{1,450}{1,000} \times 100 - 145\%$$

was not known before the end of the period, it was estimated according to previous experience that this percentage would be 150%, *i.e.*, $\left(\frac{1,800}{1,200} \times 100\right)$ and the Overheads Account was discharged by :—

$$£1,500 = \frac{150 \times 1,000}{100}$$

Therefore there remained in production instead of £1,900 actually £1,950.

This method has the advantage that it shows continuously whether the estimated percentage of wages is sufficiently correct;

for the " overheads in production " account should theoretically always be equalised at the end of the period, *i.e.*, the balance should be nil. Otherwise the balance indicates that an over- or under-estimation of the percentage has taken place, and this can be corrected easily during the next period. It depends on the aptitude of the accountant to keep this balance low, and experience has shown that this is possible to such an extent that the error, or rather the incorrectness involved in the method, can be neglected.

These proposals admittedly offend against the rules of orthodox accountancy which forbid the booking of any " fictitious " figure, *i.e.*, a figure not based on an actual process of payment or at least on generally defined and accepted rules of calculation, such as those for depreciation. In the method described figures are used which are merely estimated and are vague enough to cause a scrupulous accountant to feel uneasy ; but the advantages which could be obtained from this method in practice are so great that, in the author's opinion, they outweigh such doubts.

## B. STOCKTAKING[1]

**1. The Purpose of Stocktaking.** A further instrument of accountancy is stocktaking, which is sometimes compared with a " snapshot " of the state of some accounts, while the account in the ledger gives by the sequence of its figures a " film reel " of the changes of the object concerned during a certain period. The purpose of stocktaking was formerly twofold. On the one hand, it was necessary to divide the balance of any " working account " into two parts, the one produced by a change of quantity, the other by a change of price ; on the other hand, the balance of some accounts had to be checked at a certain time, mostly the end of the financial year of the concern, *e.g.*, December 31st, 12 midnight, in order to ensure that the figures in the ledger corresponded to the actual stocks, and to be able to undertake devaluations of these stocks where necessary.

If the mixing of changes of stocks and prices in one and the same account is avoided, *i.e.*, if " working accounts " are no longer used in the system of accountancy in the concern in question, the first of these two purposes no longer exists, the splitting of

[1] See H. T. Hildage, T. G. Marple, F. L. Meyenberg. " The New Management," pp. 162–165. Macdonald and Evans, London, 1938.

the balance now being given by the stock account and the result account. It is already mentioned that the "working account" must be considered as obsolete and should be avoided in all circumstances. Thus we are entitled to neglect the first purpose of stocktaking in further considerations. It is mentioned only because it can still be found in many otherwise up-to-date publications, and in order to draw attention to the very fact of it being obsolete.

The other purpose, however, still continues, and it is a very important one, much more important than is realised by many production men who are only too often inclined to consider stocktaking as an unnecessary interruption of their own work and an exaggeration of administrative measures. It can, of course, not be denied that an unpleasant by-result of stocktaking, when carried out in the usual manner, is some disturbance of production, sometimes even a complete stoppage for some days. It depends on the ability of the man who is responsible for the organisation of the stocktaking how far this loss of time can be diminished; but the production man should not forget that, on the other hand, this annual stocktaking offers a unique opportunity for him to attend to the order, tidiness and cleanness of his shops. It will be shown later that the purpose of the annual stocktaking and these favourable consequences can be obtained by a more modern method, the "continuous stocktaking," without the disadvantages mentioned before, but some remarks may first follow about the usual form of stocktaking in industrial works.

**2. The Procedure of Stocktaking.** The procedure of stocktaking falls into two parts: the obtaining of the figures of the quantities concerned, and the evaluating of these figures. The first part must be done in the shops, the second is office work.

Now remembering that stocktaking can be called a "snapshot" of the state of affairs at a certain moment and that this state can and will change quickly, it is necessary to have a complete record with full details required for the later evaluation, by which time that actual state has long disappeared, and cannot be remembered with sufficient accuracy. Furthermore, being aware of the fact that this is a work which in large industrial concerns, such as most iron and steel works, needs the help of scores or even hundreds of men, it is clear that very careful preparation and

organisation of stocktaking is necessary if important details needed for the evaluation are not to be missed afterwards. How this work is to be arranged can be decided only in the individual case. In general perhaps the following main features can be given :—

The works should be divided into districts and one man be responsible for the stocktaking in each district. He must be familiar with the work in the district, but should preferably not be the man who is responsible for the work in it in normal times.

He will have as many assistants as necessary and the work can be distributed among them by sub-division of the district either geographically or according to the material concerned, *i.e.*, one man takes the raw material, another the semi-finished goods, a third the tools, etc.

A carefully developed, printed or duplicated form shows what details are needed for all materials that have to be recorded, and where these details should be entered. Thus it is necessary not only to give particulars as to quality, weight and dimensions of material, but also the degree of work already applied to the material in the case of semi-finished or finished products so that the costs of this work can be calculated and the value determined.

Regard must be taken whether the material in the stocks has already been paid for at the time of stocktaking or not ; in the latter case it must be considered as the supplier's property and ought not to be included in the stocks. The same applies to finished goods, already paid for by the customer but still stocked in the works on his request, and similar allowance should be made for raw material and finished goods on the way from supplier or to customer at the time of stocktaking.

Further, it is necessary to mark all objects considered to be partly or wholly rejects or obsolete in order to be able to evaluate them correctly and to send them to the scrapheap if they are completely useless.

Finally care must be taken not only that the stocktaking is complete through the whole works, *i.e.*, that no small room or corner has been overlooked, but also that the reports all arrive in office and are kept there in good order so that their completeness can be checked easily. Whether the stocktaking shall refer to materials, semi-finished and finished goods only, or shall

include also consumable stores, tools, jigs, gauges, machines, apparatus with all accessories, etc., *i.e.*, the whole plant, depends on the peculiar conditions of the individual case: the management has to put down clear regulations beforehand how far to go in this respect.

It will be clear from this description that stocktaking can form an excellent basis for clearing the works of excessive material in the shops that should correctly be in the stores, broken or useless parts that are kept by some over-cautious foreman, and obsolete products or machinery that could be sold at reduced price or translated into useful goods at comparatively small expense, etc.

The evaluation of the stocks (this expression taken in the widest sense of the word) based on the vast bulk of reports streaming into the office after the annual stocktaking is a big additional job that must be done beside the usual routine work and is mostly discharged by many hours of overtime unless the engagement of temporary helping hands is preferred. Everybody knows that both measures have their drawbacks: the temporary assistants need time before they can be really helpful and long hours of overtime tend to deteriorate the quality of the office work during the whole working time; but the author does not know any other way to overcome the difficulties which arise from this sudden run of work on the office.

The problem on what lines to carry out the actual evaluation will be dealt with in detail later in the book. Here it may be sufficient to mention that raw material is usually valued at the price at which it is put into stock; semi-finished and finished goods at production costs; and all items that belong to the plant at prime costs minus a suitable amount of depreciation. But it is the custom—and one may even say the duty—of a careful accountant to reduce the value of the result, if he thinks necessary, according to market conditions compared with those upon which the original evaluation has been based. It is, however, the opinion of the author that this second step should be taken separately from the first in order to be able to compare the original value of the stock with that found in the books when closing them at the end of the financial year, and also in order to know exactly what the actual devaluation amounts to.

**3. Continuous Stocktaking.** As already mentioned, there has been developed in the last twenty years another form of stock-

taking which avoids completely the drawbacks connected with the usual one, *i.e.*, the stoppage and disturbance of production and the accumulation of surplus work in the office at the beginning of the new financial year. There is, however, one condition to be definitely fulfilled before one can think of replacing the usual form of stocktaking by the continuous one; that is, that there must be a really first class organisation of stores and accountancy, a fact which will again be checked by the continuous stocktaking. The idea on which this new form is based is that the accounts in the ledgers reflect the actual conditions in the works at any moment; taking that for granted, the checking of the balance of an account by actually weighing, counting, or inspecting the stock can be done at any time and distributed at will over the whole year. A special gang of men under a suitable foreman should be entrusted with this job and the checking can be done according to a carefully prepared plan, which may be kept secret so that the inspection and checking of a stores or department comes unexpectedly to its foreman or departmental manager. The plan should be arranged so that every place in the works is inspected at least once a year, and possibly twice or three times, and any discrepancies between the books and this inspection must forthwith be cleared and the books corrected accordingly.

In order to obtain at the end of the year the figures which are now given by actual stocktaking, the figures of the books are then taken as correct, and experience in works where the new method has been introduced shows that this can be done with sufficient safety. Anyone who has ever been responsible for stocktaking in a large industrial works knows that no absolute correctness can be expected from this work, even if the utmost care is taken. Some mistakes always creep in, and the final uncertainty of the figures will not be less than that of the figures in the books if—to repeat the necessary condition for applying the method of continuous stocktaking—a first-class organisation of stores and accountancy exists in the works.

That applies especially to the account of semi-finished goods which is sometimes mentioned as one of the reasons against the method of continuous stocktaking. On the contrary, the author has sometimes found that the accuracy of the new method in regard to this account was greater than the old one. And how much strenuous and time-consuming work could be saved!

Moreover, as modern production tends to limit the "work in production" as much as possible, and has succeeded in this direction at a formerly unheard of extent, a mistake in the balance of the account of semi-finished goods no longer has such an influence on the total result.

Another objection made against continuous stocktaking is that it is more expensive than the old method. It is impossible to give a general answer to this statement; it may be true in this or that case, but certainly not always. Besides, it is very difficult to evaluate in £ s. d. all the advantages offered by the new method so exactly that a fair comparison based on money figures alone is possible. In these circumstances it is recommended that the new method be introduced without discarding the old one, to calculate carefully the costs of both as far as possible, and then to decide which should be applied in future.

CHAPTER III

# THE RESULTS OF ACCOUNTANCY

## A. THE BALANCE SHEET AND THE PROFIT AND LOSS ACCOUNT

ACCOUNTS and stocktaking are the two necessary and complementary instruments of accountancy.

The link between them, the combination of the results of the stocktaking and the book-keeping in the accounts, is the balance sheet and the profit and loss account. This is not the place to show in detail how these important financial statements are built up from the accounts ; that must be left to the special books on accountancy and is outside of the scope of this book ; but the reader should be familiar to some extent with the structure of these statements and should learn "to read a balance sheet," *i.e.*, to understand the meaning of the individual items, their connection, and how to order and to compare them with each other so as to obtain a clear and truthful survey of the economic position of the works concerned. For this reason the following explanations may be useful.

The *balance sheet* shows on the right-hand side the assets, *i.e.*, all properties and possessions, and on the left-hand side the liabilities, *i.e.*, the debts and the investments. The latter consist of the original capital as well as of the reserves built up in the course of the business. As the balance sheet has the form of an account, a profit appears on the left side (under liabilities) and a loss on the right (under assets).

The *profit and loss account* is a collection of the balances of the individual accounts, *i.e.*, a detailed explanation as to how the profit or loss, as shown in the balance sheet, is composed of various items characterised by the individual accounts.

The table in Fig. 4 illustrates how the balance sheet and the profit and loss account can be developed from the accounts of the ledger. The example is not taken from a very modern publication

| Accounts | Gross balance | | Net balance | | Balance sheet | | Profit and loss account | |
|---|---|---|---|---|---|---|---|---|
| | Dr. | Cr. | Dr. | Cr. | Liabilities | Assets | Profit | Loss |
| Number of column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Capital .. .. .. | | 100,000 | | 100,000 | 100,000 | | | |
| Plant .. .. .. | 148,000 | | 148,000 | | | 148,000 | | |
| Machinery .. .. | 13,100 | 50 | 13,050 | | | 13,050 | | |
| Equipment .. .. | 9,300 | 50 | 9,250 | | | 9,250 | | |
| Cash .. .. .. | 42,700 | 42,500 | 200 | | | 200 | | |
| Bank .. .. .. | 500 | 5,500 | | 5,000 | 5,000 | | | |
| Debtors .. .. .. | 97,950 | 37,500 | 60,450 | | | 60,450 | | |
| Creditors .. .. | 23,500 | 128,000 | | 104,500 | 104,500 | | | |
| Reserves .. .. | | 6,000 | | 6,000 | 6,000 | | | |
| Depreciation .. .. | | 13,200 | | 13,200 | 15,871 | | | 2,671 |
| Bad debts account .. | 50 | 800 | | 750 | 750 | | | |
| Profit and loss account— | | | | | | | | |
| Balance last year .. | | 500 | | 500 | | | 500 | |
| Finished goods .. .. | 6,500 | 33,000 | | 26,500 | | 6,000 | 32,500 | |
| Raw material .. .. | 13,000 | 300 | 12,700 | | | 2,500 | | 10,200 |
| Consumable stores .. | 1,543 | 43 | 1,500 | | | 300 | | 1,200 |
| Maintenance material .. | 750 | 10 | 740 | | | 125 | | 615 |
| Repairs .. .. .. | 1,743 | 13 | 1,730 | | | | | 1,730 |
| Discounts .. .. | 1,100 | 50 | 1,050 | | | | | 1,050 |
| Taxes .. .. .. | 4,600 | | 4,600 | | | | | 4,600 |
| Interest and commissions | 2,150 | 1,050 | 1,100 | | | | | 1,100 |
| Rents and rates .. | 130 | 1,800 | | 1,670 | | | 1,670 | |
| Salary and wages .. | 3,800 | 50 | 3,750 | | | | | 3,750 |
| Net profit .. .. | | | | | 7,754 | | | 7,754 |
| TOTAL .. .. .. | 370,416 | 370,416 | 258,120 | 258,120 | 239,875 | 239,875 | 34,670 | 34,670 |

FIG. 4. Connection between ledger-accounts and balance-sheet and profit and loss account.

and therefore contains some of the defects which are criticised above. This is of no consequence for the present purpose. The important matters are not the types or names of the accounts and the figures, but the connections between the various vertical columns of this table.

Columns 1 and 2 with the heading " Gross balance " show for each account and for both sides, the debit and the credit side, separately, the sums of the figures which have been booked to the account in question during the period for which the balance has to be struck. The addition of both columns gives, according to the rules of booking by double entry, equal sums, the first proof that the booking has been done correctly from the arithmetical point of view. The next two columns, 3 and 4, under the heading " Net balance," show similarly for each account the balance, which has been found when closing the account at the end of the period for which the balance sheet is to be made. Again the addition of both columns gives equal sums, the second proof of correct booking. The figures of the four columns 1 to 4 are now transferred to the columns 5 to 8, booking the liabilities and the investments, *i.e.*, the original capital as well as the reserves, in column 5, the assets in column 6, the profits in column 7, and the losses in column 8. As the summing up of column 5 and column 6 as well as that of column 7 and column 8 must give equal sums respectively, the " Net profit," the figure in the last row of columns 5 and 8 results as the difference between the sums of the other figures in columns 5 and 6, and columns 7 and 8. A " Net loss " would likewise appear in columns 6 and 7.

The method is so simple that no further explanation seems to be necessary, except as regards a few accounts, where the development of the figures in columns 5 to 8 from those in columns 1 to 4 shows some peculiarities. The " Depreciation " account has been taken from the previous year at £13,200, but it is inserted as a liability in column 5 at £15,871 and the difference of £2,671 as a loss in column 8. This last amount is the increase of depreciation on plant, machinery and equipment, which was found necessary when considering the condition of these assets in comparison with that at the beginning of the year. A distribution of this depreciation over the year is to be preferred. The figures of the assets of the following four accounts, finished goods, raw material, consumable stores, and maintenance material have been found

by actual stocktaking and careful calculation, taking into consideration the market conditions, etc. ; the figures of profit and loss on these accounts result by comparing the stocktaking figures in column 6 with those in the columns 3 and 4 of the "Net balance." The kind of booking on these four accounts shows that they are kept as a mixture of "stock" accounts and "results" accounts, a procedure the defects of which have been explained above. The transformation of the columns 5 and 6, and 7 and 8 respectively into the usual form of the balance sheet and the profit and loss account is obvious.

## B. INTERPRETATION OF A BALANCE SHEET

Having become familiar to some extent with the principles of "accountancy" and the development of the balance sheet and the profit and loss account, readers may be interested to have some hints on how to read a balance sheet, *i.e.*, how to draw from the figures of a balance sheet conclusions regarding the economic state of affairs of the industrial works concerned.

These hints can only be a guide to such a study ; the actual procedure can be understood best from examples in practice, where the figures of the balance sheet relate to matters and facts within the readers' experience, so that they are not mere abstractions, devoid of reality.

One other preliminary remark is desirable. When reference is made to balance sheets and profit and loss accounts, these terms relate only to those internal statements which reflect plainly and openly the true state of affairs, as revealed by a correctly kept ledger. Apart from any fraudulent reason for changing or concealing figures, there are many motives which may lead to summarising, combining, or even suppressing figures in the balance sheet to be published, for reasons connected with the legislation on rates and taxes, or regulations of insurance companies, etc. None of these kinds of balance sheets is taken into account.

**1. Diverse Arrangement of the Figures of the Balance Sheet.** A balance sheet has always to be adapted to the special circumstances of the works to which it refers. It is therefore not possible to give a pattern which is generally applicable. Nevertheless a scheme has been represented in Fig. 5 in order to facilitate the explanation of the hints mentioned above. It is so arranged as

| LIABILITIES | ASSETS |
|---|---|
| Nominal capital | Fixed works property |
| Nominal capital | 1. Estates |
| (ordinary shares, preference shares) | 2. Buildings |
| | 3. Machinery |
| | 4. Equipment |
| | 5. Tools and implements |
| Reserves | 6. Patterns |
| Reserves of various kinds | 7. Patents |
| (legal, free, special ; del credere, | |
| guarantee.) Welfare and pensions fund. | Floating works property |
| | 8. Material |
| | 9. Semi-finished products |
| Long term debts | 10. Finished goods in the works |
| Mortgage debts | 11. Finished goods in consignment stores |
| Loan debts | 12. Banking credit |
| Debentures, bonds, | 13. Claims founded on bills of exchange |
| Workmen's savings. | 14. Cash, cheques, postal orders |
| | 15. Trade debtors |
| Short term debts | Neutral property |
| Bank debts | 16. Estates not used for the works |
| Debts founded on bills of exchange | 17. Participation in other companies |
| Trade creditors | 18. Securities |
| Instalments received. | 19. Mortgage claims |

FIG. 5. Usual sequence of items of a balance sheet.

to cover at least a large proportion of the usual kinds of balance sheet, thus contributing to greater famliarity with the generally used wording.

For a clear preliminary survey it is recommended that on the left side of the balance sheet the nominal capital (ordinary shares and preference shares, assuming the concern is a joint stock company), and the reserves of various kinds, including for example a welfare and pensions fund, should be strictly separated from the liabilities, which should be divided into long term and short term debts. On the right hand side the assets may similarly be divided into works property and neutral property. The latter consists of all property in the hands of the company, not used directly for the purposes of its business, but held in reserve for future development, *e.g.*, estates and buildings bought for later enlargement of the works or only for investing capital temporarily in excess of requirements, shares of other companies, securities, etc.

The separation of these figures relating to neutral property, and generally of all results of such neutral business, from transactions arising from the ordinary purposes of the undertaking and usually set out in the articles of association of the company, is very useful and contributes considerably to a clear survey of the business affairs.

The works property should again be divided into fixed assets and floating assets as shown in detail in Fig. 5.

The usual sequence of the individual items of a balance sheet as given in Fig. 5, should, however, for the purpose of checking the quality of the balance, be changed as illustrated by Fig. 6. There the assets are arranged according to their realisability, or as it is usually expressed, their "liquidity," and the liabilities according to their urgency. By comparing, for example, the floating assets with the short term debts, or generally assets and liabilities according to their liquidity, valuable conclusions can be drawn about the economic status of an industrial undertaking.

**2. Management Ratios.** Another good test in criticising a balance sheet is to compare the ratio of various items on the same or both sides of the balance sheet with the corresponding figures usual in works in the same branch of industry. In this connection the statistics in Fig. 7 may be of interest. The figures are taken

| Liabilities | Assets |
|---|---|
| (According to urgency) | (According to liquidity) |
| Instalments received | 14. Cash, cheques, postal orders |
| Debts founded on bills of exchange | 13. Claims founded on bills of exchange |
| Trade creditors | 12. Banking credit |
| | 18. Securities |
| Workmen's savings | 19. Mortgage claims |
| Bank debts | 15. Trade debtors |
| Loan debts | 8. Material |
| Mortgage debts | 10. Finished goods in the works |
| | 11. Finished goods in consignment stores |
| | 9. Semi-finished products |
| | 7. Patents |
| Welfare and pensions fund | 3. Machinery |
| Reserves of various kinds (legal, free, special) | 5. Tools and implements |
| Debentures, bonds | 4. Equipment |
| Nominal capital | 6. Patterns |
| Reserves (del credere, guarantee) | 1. Works estates |
| | 2. Works buildings |
| | 16. Estates not used for the works |
| | 17. Participations in other companies. |

FIG. 6. Sequence of items of a balance sheet according to urgency and liquidity respectively. The numbers on the asset side show the sequence of Fig. 5.

from a publication nearly a dozen years old, but comparison with some individual, more modern figures of American origin show relatively small differences.

If any trend of development during the last years can be observed, it is that the fixed assets are growing in proportion to the floating assets ; this is certainly due to the greater mechanisa-

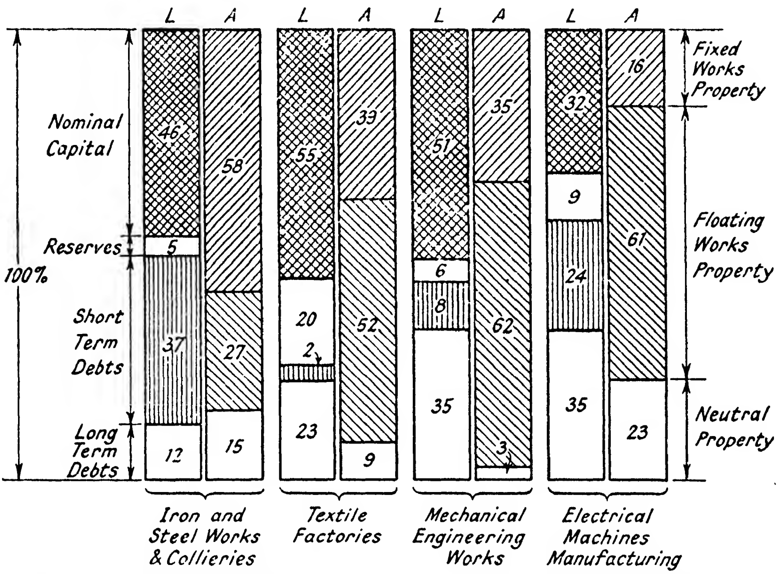


FIG. 7. Liabilities (L) and assets (A) of various branches of industry.

tion of the works on the one hand, and, on the other, to the modern tendency of keeping the stocks small and the actual work in constant flow.

These statistics are given rather to draw attention to the characteristic differences between various branches of industry than to be taken themselves as a guide. They show what a dominant influence the plant costs exercise in the iron and steel industry in proportion to the floating assets, as compared with conditions in other industries, *i.e.*,

Iron and steel industry and collieries .. $\frac{58}{27} = 2{\cdot}15$

Textile factories .. .. .. .. $\frac{39}{52} = 0{\cdot}75$

| | |
|---|---|
| Mechanical engineering works .. .. | $\frac{35}{62} = 0{\cdot}56$ |
| Electrical machines manufacturing .. | $\frac{16}{61} = 0{\cdot}26$ |

It is obvious that this ratio determines to a great extent the business policy, *e.g.*, in an industry such as iron and steel, where an unusually large part of the invested capital must be used for the plant, special attention is necessary that this ratio does not increase to a dangerous extent. Further, great care should be taken as regards expert maintenance and the provision of sufficient reserves for replacement of out-of-date machinery and equipment, for in this industry these items play a more important *rôle* in the costs than in other industries; they can be kept comparatively low in the long run only if they are continuously and carefully controlled from the start by experts.

There are other such ratios, which are worth while noticing. From the well-known Management Handbook [1] only the following examples can be mentioned, together with the figures for iron and steel works, taken from the same source :—

| | |
|---|---|
| Percentage of surplus net profit earned on sales | 10·5% |
| Average turnover of total capital employed .. | 50% |
| Average turnover of inventories forming a measure of the rapidity with which stocks of goods are resold and replenished .. .. | 502% |
| Average turnover of fixed property investment | 70% |

3. **Depreciation.** Further information is given by the investigation of the depreciation account. Intimate knowledge of the internal working conditions as well as of the market and its probable development is necessary when checking whether the figures of depreciation are too low, sufficient, or exaggerated. In the last case, which is often intentional, there is concealed in the figure of depreciation a reserve which would be better shown separately in a special account.

[1] L. P. Alford, The Ronald Press Company, New York.

In this connection it may be mentioned that it increases the clearness of survey of the internal conditions if the original value of the invested property, plant machinery, equipment and stock-in-trade, is kept unchanged in the balance sheet and the depreciation is entered as a summary of the figures of all former years with the figure for the last year separately, so that the momentary value of all accounts, as affected by depreciation, is clearly evident.

Whether this is shown on the asset side by subtractive items or on the liability side as a special account is practically immaterial; the latter method seems to be more in conformity with the rules of double-entry book-keeping and indicates more clearly that money actually has to be put aside for the replacement of out-of-date and worn-out machinery, etc.; but the former method may provide for a simpler survey of the real value of the various items.

The question is more or less a matter of taste; the sometimes heated discussion on this subject is an exaggeration of a point of detail. It is better to keep in view only pertinent features which are really decisive as to the value of the balance sheet. For the rest there will be opportunity to come back to the problem of depreciation in greater detail.

**4. Limits of the Balance Sheet as an Economic Guide.** So much for the interpretation of the balance sheet. But it may not be superfluous to repeat that the hints and the figures given in this connection are only examples to show how an expert can learn something about the state of affairs in an industrial works from its balance sheet.

Further, it should not be overlooked that a balance sheet is to some extent only the picture of a moment, *i.e.*, the end of a business year, and that the real trend of development—which is usually more important than such a "snapshot"—can only be discovered by comparing a consecutive series of monthly or yearly balance sheets.

Finally, there are "imponderables" in each industrial undertaking, such as market conditions, goodwill, tradition, *esprit de corps*, etc., which cannot be expressed in terms of money and therefore do not appear in the balance sheet, but may nevertheless form valuable assets or dangerous liabilities. They should be the subject of the report accompanying the balance sheet and cannot

be dealt with by the responsible accountant alone. Here the close co-operation of all executives—general manager, commercial manager, works manager, secretary, etc.—is necessary, if it is not preferred to seek the opinion of an independent management consultant.

CHAPTER IV

# CONNECTION BETWEEN FINANCIAL ACCOUNTANCY AND WORKS ACCOUNTANCY

THE modern development of accountancy—in the sense explained by Fig. 1—has gone so far that a division into financial and works accountancy is often considered as a necessity based on the different nature of both. It may even be found in practice that a kind of contrast has grown up between them. Nothing is more absurd. Really they are a whole, two branches springing from the same trunk, and the division has been made only because it is expedient, or in large works even necessary for practical reasons ; but the common origin should never be forgotten, and a connecting link should be carefully maintained to ensure close connection and to avoid discrepancies between the two branches.

For this purpose it would be sufficient to have, in financial accountancy and works accountancy, only one account and counter-account, which may be called " works account," but it is usually thought more convenient to have several corresponding accounts in both cases. The financial accounts are thus made more independent for the development of the monthly and yearly balance sheets and profit and loss accounts, and the absolutely necessary and complete agreement between the two sets of accounts can be more easily maintained.

## A. AN EXAMPLE OF WORKS ACCOUNTANCY

Fig. 8 shows diagrammatically an example of how this problem may be solved in a non-integrated iron and steel works. It is taken from the German publication mentioned in the preface to this book and must therefore be considered as at least a semi-official instruction as to how all iron and steel works in that country have to arrange their system of accountancy. Although this diagram may be clear generally with the help of the explanations given on it, some few remarks may be added.

Some of the financial accounts show a sub-division into two

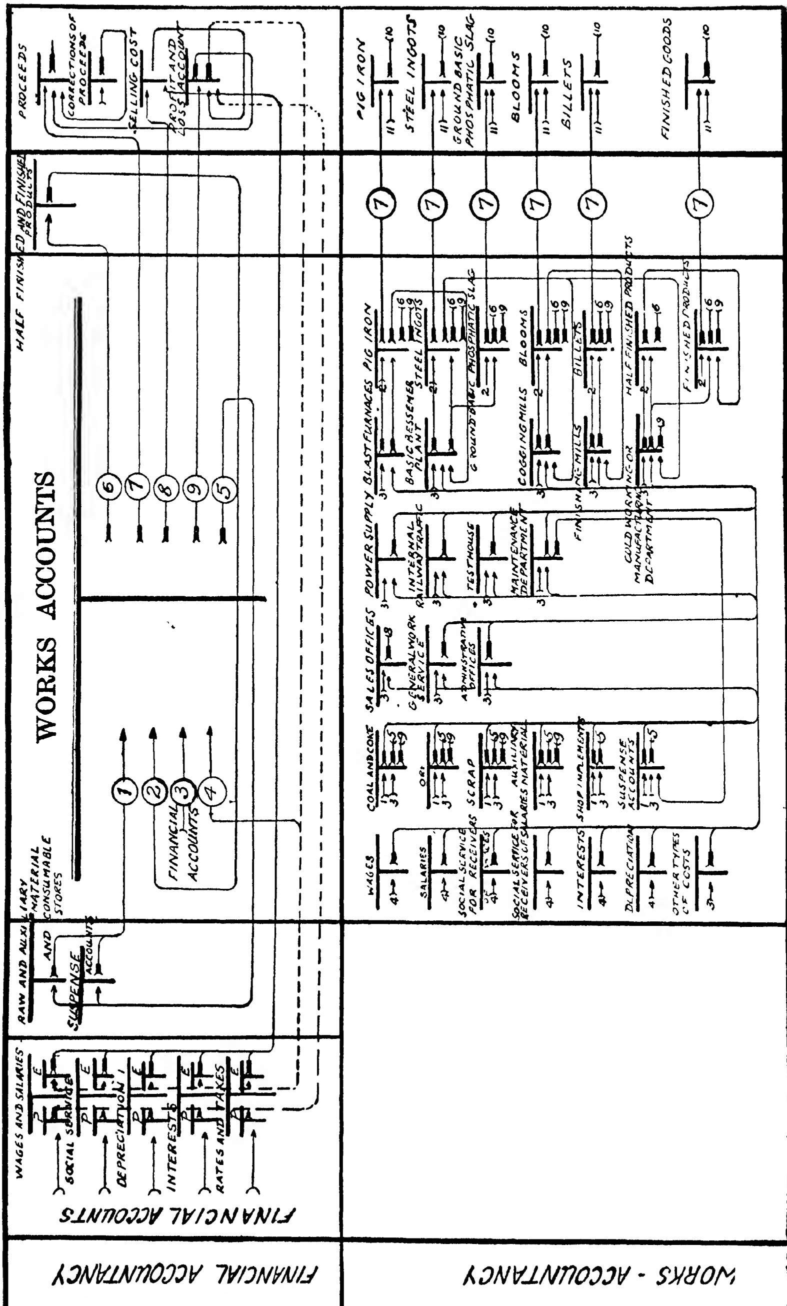


FIG. 8. (See opposite page.)

FIG. 8. Diagrammatic representation of the course of bookkeeping, and of the connection between financial and works accountancy.

—— Bookings during and at the end of a month.

- - - - Bookings at end of business year.

→ Charging an account; >—c Discharging an account. — The figures indicate the bookings of the works accountancy and the parallel bookings of the financial accountancy.

1., 2. At the beginning of a month booking of stocks from one month's account to the next month's.

3. Current arrival of materials, etc.

4. Charging of expenditure.

5., 6. At the end of a month : booking of stocks from one month's account to that of the next.

7. Total costs of goods despatched.

8. Selling costs.

9. Revaluations.

10. Proceeds by sales.

11. Results of despatch.

accounts marked "P" and "E," signifying "Payment" and "Expenditure." This arrangement allows of distributing into nearly equal monthly amounts of expenditure, the incoming or outgoing payments which occur only once or rarely during the business year.

This procedure is applied in order to adapt the figures of accountancy to the demands of the costing system and of production control. In both cases it is of the utmost importance to eliminate from the basic figures, which must be in conformity with the corresponding data in the financial accounts, all fluctuations that are not actually caused by changing internal working conditions, but are due to unusual and singular internal expenditure or lump sum payments to and from outsiders, such as taxes, rates, interests, etc. Otherwise fluctuations due to these latter causes would overshadow the fluctuations resulting from changing working conditions to such an extent that these, which alone are of interest from the point of view of costs and control, could not be discerned clearly enough.

With that explanation the nature of "suspense accounts" is also made clear. The term "suspense accounts" is used in Fig. 8 in two places, in the financial and in the works accountancy. As already mentioned such accounts are used in financial accountancy mainly for the entry of irregular payments to and from outsiders. In the works accountancy, however, suspense accounts are used where an internal expenditure of some amount is necessary, the costs of which should not be charged to the period in which they happen to occur, but should rightly be distributed over several months or even years. As an example may be mentioned the cost of an expensive die for forging or pressing mass production parts, which can be used for more than one year's production, etc. It would be possible to speak of "active and passive suspense accounts," the former being used for the subsequent charging of parts of a payment which has already been made, the latter for the preliminary booking of expenses, the total of which will be equal to a future payment, which can be anticipated with sufficient accuracy.

The "Works Account" in the financial accounts is characterised above as the main and only necessary connection between the two sets of accounts. The nature of this account is such that at the end of a month, as soon as all bookings for this period have

E.C.

| | | | |
|---|---|---|---|
| 1.[1] Stock at beginning of the month : | | 5. Stock at the end of the month : | |
| (a) Raw and auxiliary materials and consumable stores ... ... ... | £250,000 | (a) Raw and auxiliary materials and consumable stores ... ... ... | £150,000 |
| (b) Suspense accounts ... ... ... | £25,000 | (b) Suspense accounts ... ... ... | £20,000 |
| 2. Stock at beginning of the month : Semi-finished and finished products ... | £250,000 | 6. Stock at the end of the month : Semi-finished and finished products ... | £600,000 |
| 3. Payments during the month = goods received | | 7. Total costs of the despatched products ... | £1,770,000 |
| (a) Raw and auxiliary materials and consumable stores ... ... ... | £1,200,000 | | |
| (b) Sundries ... ... ... ... | £150,000 | | |
| 4. Expenditure during the month = consumption of goods : | | 8. Contained in works accountancy : | |
| (a) Wages ... ... ... ... ... | £500,000 | (a) Increase of plant, machinery, etc. ... | £50,000 |
| (b) Depreciation ... ... ... ... | £75,000 | (b) Selling costs ... ... ... ... | £15,000 |
| (c) Interests ... ... ... ... | £25,000 | | |
| (d) Sundries ... ... ... ... | £100,000 | | |
| 9. Profit by revaluation : | | 9. Loss by revaluation : | |
| (a) On material accounts... ... ... | £20,000 | (a) On material accounts... ... ... | — |
| (b) On product accounts ... ... ... | £25,000 | (b) On product accounts ... ... ... | — |
| (c) On cost position accounts ... ... | — | (c) On cost position accounts ... ... | £15,000 |
| | £2,620,000 | | £2,620,000 |

[1] The numbers of the bookings in Fig. 9 correspond to the figures of the booking lines in Fig. 8. The booking (8a) is omitted in Fig. 8; and of the booking (9) only the booking (9c) is represented in Fig. 8.

FIG. 9. Booking on the " Works Account " in the financial accounts during a month.

D

been made, the account must show a zero balance. Again, this may best be explained by an example, as reproduced in Fig. 9. No further discussion of this illustration seems to be necessary, with the exception perhaps of the transactions No. 9 ; profit and loss by revaluations. They are divided into three parts :—

(*a*) On material accounts.
(*b*) On accounts of products.
(*c*) On accounts of cost positions.

Revaluations on material accounts may become necessary if the consumption of material is not calculated at book value in the total cost of the products, or if corrections must be made in respect of the trend of the market prices, etc.

Revaluations under (*b*) are explained by the following two examples, the first showing a profit and the second a loss.

STOCK ACCOUNT OF THE PRODUCT: STEEL BARS

| | |
|---|---|
| (1) | |
| Stock at the beginning of the month 10,000 tons at £5 0s. 0d. | £50,000 |
| Production during the month 30,000 tons at £5 10s. 0d. .. | £165,000 |
| | £215,000 |
| Despatched 28,000 tons at £5 10s. 0d. .. .. .. | £154,000 |
| Stock at the end of the month 12,000 tons at £5 0s. 0d. .. | £60,000 |
| Loss .. .. .. .. .. .. .. .. | £1,000 |
| | £215,000 |
| (2) | |
| Stock at the beginning of the month 10,000 tons at £5 0s. 0d. | £50,000 |
| Production during the month 30,000 tons at £5 10s. 0d. .. | £165,000 |
| Profit .. .. .. .. .. .. .. .. | £1,000 |
| | £216,000 |
| Despatched 32,000 tons at £5 10s. 0d. .. .. .. | £176,000 |
| Stock at the end of the month 8,000 tons at £5 0s. 0d. .. | £40,000 |
| | £216,000 |

Revaluations under (*c*) may be necessary, if standard additions are used for covering the overheads of a shop or " cost position," and if these standards involve an over- or under-estimation in comparison with the actual overheads of the same period.

It may be that these remarks on the bookings under No. 9 of Fig. 9 are not quite clear to the reader who is confronted for the

first time with such terms as "standard additions," "cost positions," etc., but this problem of revaluation will be referred to again and these terms explained in greater detail.

## B. CRITICISM OF THE EXAMPLE OF WORKS ACCOUNTANCY

The fact that the previous section deals largely with the details of the works accountancy in a non-integrated iron and steel works as given in Fig. 8, does not mean that the author is completely in agreement with the scheme. On the contrary it is useful to consider whether this scheme is really the clearest method of tackling the problem involved. It will be shown that—in the author's opinion—that is not the case ; but the reader is expressly invited to form his own opinion as the matter is to some extent one of taste and it cannot be denied that the method illustrated by Fig. 8 is practicable and leads to a correct result *if carefully handled.* As already mentioned this method has been practically made standard (in Germany) by government decree, and that fact alone is sufficient to guarantee its usefulness. On the other hand, the main defect in the scheme is important enough for its use in practice to be discussed more in detail.

**1. Accounts of Cost Positions.** In order to make clear what is really meant by these introductory remarks, the accounts of the works accountancy given in Fig. 8 should be considered more systematically. They may be classified into :—

(1) *Accounts of types of costs.*
- (*a*) Stock accounts of raw material, auxiliary material and consumable stores.
- (*b*) Accounts of wages, salaries and social services.
- (*c*) Accounts of depreciation, taxes, rates, interests.
- (*d*) Suspense accounts.
- (*e*) Accounts of other expenses.

(2) *Accounts of positions of costs.*
- (*a*) Accounts of administrative departments.
- (*b*) Accounts of auxiliary departments.
- (*c*) Accounts of supplementary departments.
- (*d*) Accounts of main departments.

(3) *Accounts of products.*
- (*a*) Stock accounts of products.
- (*b*) Result accounts of products.

(4) *Accounts of selling costs.*

(5) *Accounts of rebuilding costs of plant, machinery, etc.* (Omitted in Fig. 8.)

The reader may remember what was said previously about accounts of positions of costs, and that the use of this characteristic of distinction in that part of industrial accounts which is especially denoted as "accountancy" (see Fig. 1), is not recommended. This principle is completely and intentionally neglected in the scheme given in Fig. 8; this is regrettable because in practice considerable difficulties must arise. As the considerations leading to this statement are especially suitable for elucidating the whole structure of industrial accounts, they will be dealt with in greater detail. Moreover this will be helpful later on, when the costing system is explained.

**2. Classification of Costs.** The total costs of an industrial undertaking can be classified from three different points of view, logically connected, but mutually exclusive. These are :—

(1) The nature or types of costs,

(2) The positions of costs, and

(3) The bearers of costs, mostly known as works orders.

Each cost item can be characterised according (1) to its nature or type, (2) to the place or position in the works, where it occurs, and (3) to the order, the completion of which is assisted by it. It is necessary that the "accountancy" gives a complete survey of the total costs incurred during a certain period. No item should be omitted, but neither should an item be counted twice. This can best be accomplished if only *one* aspect of division is allowed, because then the book-keeper will never be in doubt about which account he has to select for his booking.

This, however, is not the only advantage of strict adherence to the principle just explained. Book-keeping by double entry, as stated earlier, has certain great advantages, but that does not mean that one should be blind to its inherent disadvantages in cases where the unsurpassable accuracy of the method is unnecessary. That is certainly the case if the distribution of the total costs among the various cost positions is intended. The method of booking by double entry necessitates the booking of the same figure on two accounts, and the infallibility of the method rests to a great extent on this fact. Why use it where such

accuracy is unnecessary and a statistical distribution of the total amount of an account to the various cost positions can be done by booking only half the figures ?

Costing is a branch of industrial accounts in which exaggerated accuracy only too easily develops into nonsense. The author remembers a public competition on costing methods in various branches of industry almost forty years ago, in which a prize was awarded to a work under the motto : " Whichever method you choose, the result will never be completely correct." In practice the truth contained in this motto is only too often overlooked and either an inadmissible enlargement of the clerical machinery or a belated and even insufficient delivery of the results is the inevitable consequence.

How can this tendency be explained ? Obviously only by the fact that costing systems are usually developed by accountants who are rightly proud of that marvellous instrument of accountancy, double entry book-keeping. They overlook the completely different nature of " accountancy " and " costing." After the former has given the absolute guarantee of correct total sums on the account—almost synonymous with type of costs—the simple statistical distribution of this total amount to the cost positions is sufficiently accurate. How this distribution should be done, *i.e.*, which keys should be used, will be discussed later on.

It is, therefore, recommended that all these accounts of cost positions should be removed from the works accountancy. The simplification thus obtained will best be imagined by considering the example of such an account as given in Fig. 10, with its bookings from other accounts of the same nature as indicated by asterisks.

**3. Revaluations.** Another point to which criticism of Fig. 8 may be directed is the revaluation as shown in the example of the works account of the financial accountancy (booking No. 9). Nothing can be said against revaluations under (9a), *i.e.*, of costs of material. They are certainly necessary in some cases, as explained, although they will not be frequent, if the booking of the material costs is done at book value, a method which suggests itself and can be easily understood by all concerned. Other methods—market prices and fixed standard prices—have many disadvantages (the standard price method in particular gives a

| | £ | s. | | £ | s. |
|---|---|---|---|---|---|
| Blooms : | | | Steam from waste heat boiler | 800 | 0 |
| 20,400 tons at £4 10s. | 91,800 | 0 | Scrap from own shops | 100 | 0 |
| Billets : | | | From other sources : | | |
| 1,100 tons at £4 15s. | 5,510 | 0 | 3 tons at 8s. | 1 | 4 |
| Productive wages | 2,430 | 0 | 537 tons at 10s. | 268 | 10 |
| Auxiliary wages | 715 | 0 | 1,040 tons at £2 13s. | 2,756 | 0 |
| Salaries | 210 | 0 | | | |
| Social service | 325 | 0 | | 3,925 | 14 |
| Fuel | 2,740 | 0 | Bars : | | |
| Electrical energy | 1,755 | 0 | 15,000 tons at £5 10s. | 82,500 | 0 |
| Rolls | 750 | 0 | Structural steel : | | |
| Consumable stores | 180 | 0 | 1,000 tons at £5 8s. | 5,400 | 0 |
| Material for maintenance | 290 | 14 | Light rails : | | |
| Sundries | 42 | 10 | 4,000 tons at £6 | 24,000 | 0 |
| Taxes | 1,040 | 0 | | | |
| Depreciation | 5,985 | 0 | | 111,900 | 0 |
| Share of general and administrative costs | 470 | 0* | | | |
| Roll turning shop | 410 | 0* | | | |
| Test house | 65 | 0* | | | |
| Internal traffic | 12 | 10* | | | |
| Maintenance shop | 1,095 | 0* | | | |
| | £115,825 | 14 | | £115,825 | 14 |

FIG. 10. Bar mill account.

wrong impression from the economical point of view) and the advantage of simplifying the booking work is very small.

The revaluation under 9b, *i.e.*, of production accounts, starts from an incorrect assumption : a stock account such as in the example Fig. 9 should never show a profit or loss of the kind indicated. It is only necessary to imagine what actually happens in the works and should be reflected by the entries in the account : A certain amount of material is in hand at the beginning of the month and this material has a certain value ; a new lot of material is produced but at slightly different costs and is added to the stock in hand at the beginning. A certain amount of material is despatched during the month. Who can say whether it is taken from the old stock existing at the beginning of the month, or from the new production ? Why should the despatched material be booked at the higher price of the new production and the remaining stock at the lower price of the stock at the beginning of the month, since this method alone creates a profit or loss on this account ? It is an artificial procedure justified by no consideration of actual facts.

Obviously two other methods can be used, which are both simple and reasonable : either an average price for the stock in hand at the beginning and for the new production together is calculated and the booking of the despatch and of the remaining stock is made at this average price, or the valuation of the despatched material is done at the old price of the stock in hand at the beginning of the period in so far as this despatched material is covered by the old stock, and the remainder is valued at the new price. The example of the revaluation under (9b) is then as shown in the table on p. 40.

This example shows that no profit or loss appears in the account, as it is of course only natural on a stock account which should show only the changes in quantities apart from any changes in price. No revaluation is therefore necessary.

Finally the question of revaluation according to (9c) no longer arises, if accounts of cost positions are not used in works accountancy. It has already been shown how a skilful and conscientious accountant is able to minimise the differences between actual overheads and the percentage additions used for covering the overheads as part of the costs of finished and semi-finished goods : the remainder is insignificant and can easily

## Revaluation of Stock Account

| | | | |
|---|---|---|---|
| First method :— | | Despatch : 28,000 tons at £5 7s. 6d. | £150,500 |
| either : | | Stock at end of period : | |
| Stock at beginning of period : | | 12,000 tons at £5 7s. 6d. | 64,500 |
| 10,000 tons at £5 | £50,000 | | |
| Production during period : | | | |
| 30,000 tons at £5 10s. | 165,000 | | |
| 40,000 tons at £5 7s. 6d. | £215,000 | | £215,000 |
| or : | | | |
| Stock at the beginning of period : | | Despatch : 32,000 tons at £5 7s. 6d. | £172,000 |
| 10,000 tons at £5 | £50,000 | Stock at end of period : | |
| Production : | | 8,000 tons at £5 7s. 6d. | 43,000 |
| 30,000 tons at £5 10s. | 165,000 | | |
| 40,000 tons at £5 7s. 6d. | £215,000 | | £215,000 |
| Second method :— | | | |
| either : | | | |
| Stock at the beginning of period : | | Despatch : 10,000 tons at £5 | £50,000 |
| 10,000 tons at £5 | £50,000 | 18,000 tons at £5 10s. | 99,000 |
| Production : | | | |
| 30,000 tons at £5 10s. | 165,000 | | 149,000 |
| | | Stock at end of period : | |
| | | 12,000 tons at £5 10s. | 66,000 |
| | £215,000 | | £215,000 |
| or : | | | |
| Stock at beginning of period : | | Despatch : 10,000 tons at £5 | £50,000 |
| 10,000 tons at £5 | £50,000 | 22,000 tons at £5 10s. | 121,000 |
| Production : | | | |
| 30,000 tons at £5 10s. | 165,000 | | 171,000 |
| | | Stock at end of period : | |
| | | 8,000 tons at £5 10s. | 44,000 |
| | £215,000 | | £215,000 |

disappear in accountancy by transference to the profit and loss account.

These considerations may be sufficient to characterise the position which " accountancy " occupies in the sphere of " industrial accounts " as defined by Fig. 1. Now it is necessary to turn to the second main part, the " works accounts."

# PART II

# WORKS ACCOUNTS

It is to be regretted that there is no other term which could be used as a heading for this part than the expression "works accounts." This is already used in a more special and limited sense and readers must distinguish clearly between that special meaning and that assigned to it in the following consideration, as part of the entity called "industrial accounts."

The object of the following discussion is : the analysis, distribution and collection of costs as they are summarised in individual accounts or types of costs, in order to obtain a basis :

(1) of production control and

(2) of the determination of job accounts.

Costs must be allocated systematically to the cost positions where they arise, and methods developed to connect the results of this allocation with the bearers of costs or works orders which are—directly or indirectly—the final result of the work done in the factory.

Since the types of costs or accounts of "accountancy" proper contain absolutely the whole costs, their accuracy being guaranteed by the double entry method, all that is necessary is to take the final figures of the types of costs as the starting point for the allocation of costs to the cost positions. This may seem so obvious as to be superfluous or even ridiculous. Yet how often it happens in practice that the close connection that should exist between accountancy and costing, gives place to a kind of antagonism and mysteriousness.

## CHAPTER V

# GENERAL FEATURES OF ORGANISATION OF A BIG IRON AND STEEL WORKS

Before dealing with the analysis, distribution and collection of costs and their allocation to cost positions it may be useful to consider the structure of the organisation of a big industrial iron and steel company; any misunderstanding about what is really meant by the expression "position of costs" will thus be avoided.

Nearly all undertakings in the iron and steel industry have developed to such an extent that a careful division is necessary if the whole is to be easy to survey. Various names are used in practice for the various parts, and many differences of opinion result from the fact that sometimes the same word is used by different persons for different parts. Here a nomenclature is proposed which would bring to an end such misunderstandings and could be advantageously considered as a "standard."

Distinction should be made between :—

*The Combine.* A combination of various units, more or less independent, into a whole with a common balance sheet and profit and loss account, which alone reflect the economic state of affairs of the entire undertaking.

*The Works.* One of the units forming the combine. A locally coherent plant whose balance sheet and profit and loss account may be built up independently, but forms afterwards only a part of the financial statements of the combine and must be considered as a purely internal matter.

*The Departments.* Parts of the works, which can be considered as units, each forming a place where certain technical or commercial processes are carried out, different from those in other departments. Separate balance sheets and profit and loss accounts of individual departments are exceptional.

The *technical departments* may be divided in main, supplementary and auxiliary departments.

*Main departments* produce the chief finished goods of the

works; they are, for example, the blast furnaces, the melting shops, rolling mills, and shops for further working up the rolled material to sleepers, wire, strip, etc.

*Supplementary departments* manufacture finished goods which arise out of the production of main products, such as slag grinding mills, gas cleaning plants, etc. Sometimes it may happen that these departments develop into very important parts of the works and may even become the main source of economic success. (For example, the author remembers a small iron and steel works which would certainly have been forced into bankruptcy during a period of depression had the profit of a cement and slag brick factory not helped to overcome the temporary difficulties.) Nevertheless these departments would still remain supplementary.

*Auxiliary departments* produce no saleable goods, but only render services to the main and supplementary departments, *e.g.*, the stores, the central power station, the maintenance shop, the internal traffic department, watchmen and messenger service, etc. They are sometimes supplementary departments at the same time, *e.g.*, a central power station may provide electricity not only for the works but also for outside customers, or a furnace gas cleaning plant may deliver gas to the own works as well as to other companies, etc. In this case very difficult problems of costing may arise, which will be discussed later.

Besides these technical departments there are:—

*Administrative departments* such as cashier's office, wages office, personnel, costing, etc., and

*Commercial departments* for purchasing and selling.

Many of these departments, particularly the technical, are again divided into *positions of costs* for costing and controlling purposes. For example, the melting shop may have the following positions of cost: scrap yard, furnaces, preparation of ladles, casting pit and discharging bay; the bar mill is perhaps divided into: furnaces, mill, finishing bank, stocks and despatch.

Generally, a "position of costs" should comprise only such activities as are equivalent or at least similar enough to be considered as a unit from the point of view of costs. For instance, a forge may be one position of costs, if machines of nearly the same type and size only are used and almost the same kind of work is done throughout the shop; but if hammers of various sizes are in the forge and manual work is also carried out, it may be that

one very big hammer forms a separate cost position, a group of hammers of medium size a second, the remaining small hammers a third and the manual work a fourth position. It must be left to the judgment of the responsible man how far the subdivision is carried. He needs for it sufficient knowledge of the production processes on the one hand and economical understanding on the other hand: subdivision carried too far increases the work unnecessarily; too much aggregation renders the result unreliable. This very important point is not always given the necessary consideration in practice. The decision is often left to a subordinate member of the staff in the costing department, whereas it should be actually a matter of discussion between the accountant and the departmental manager in question.

CHAPTER VI

# DISTRIBUTIONS OF COSTS TO COST POSITIONS

## A. DIRECT AND INDIRECT OR INDIVIDUAL AND GENERAL COSTS

**1. Definitions.** Before it is possible to discuss in detail how to distribute the costs as collected on the accounts to the various cost positions, a further distinction of costs is necessary, which results partly in a subdivision of some accounts, *i.e.*, into direct or individual costs, and indirect or general costs. The former are all costs which can be *freely and easily* attributed to the bearer of costs or works order, for the finishing of which they are necessary ; to the latter belong all the costs where that is not the case. Although it should be, in the interest of accuracy, the endeavour of the accountant to increase the first of these two groups as much as possible in comparison with the second, it is desirable to emphasise the expression " freely and easily." It is often found in practice that the desire to be accurate leads to exaggerations which cause unnecessary and uneconomical clerical work without actually increasing the final degree of accuracy. That may be illustrated by an example.

It is usual to allocate the costs of special drawings to the products represented by the drawings. In order to be able to do this the number of hours taken in the drawing office to make these drawings is recorded and this figure is multiplied by average costs of a working hour of the drawing office. This gives a high degree of accuracy ; but there are people who are not satisfied with this calculation because the salaries of the draughtsmen may be different and the costs of the working hours in the office vary correspondingly. They therefore insist on allocating the " correct " salary to the drawing in question thus not only increasing the clerical work, but also making the basis of their calculation depend on a more or less casual distribution of the work in the drawing office. Thus the first mentioned average method is not

only easier, but even better from the point of view of costing, apart from the fact that the "inaccuracy" thus incurred is certainly within the limits of accuracy of the whole calculation of costs. Analogous cases can be found frequently; one need only mention the work of the test house, inspection department, internal traffic, etc. Such over-elaboration draws attention away from the main subject to incidental matters, not worth while such a scrutiny.

**2. The Allocation of Direct Costs.** It is clear that by the division into direct and indirect or individual and general costs some accounts or types of costs are subdivided, especially the wages and the raw material accounts.

It is the duty of the wages office to do this job for the wages account, *i.e.*, to divide the total sum of wages of a certain period, perhaps a week, into direct and indirect wages and to allocate each part to the various cost positions where they have occurred. In a similar manner the stores control office has to deal with the raw material account, and the consumable stores account. It will be described later how wages and stores account offices can do these jobs and the means of simplification and mechanisation by which the collection, distribution and allocation of the innumerable vouchers can be facilitated. Here may only be said that the importance of these original vouchers for production control and costing purposes is, oddly enough, often underestimated; they are not made out with the necessary care and accuracy and hence the results drawn from these figures are likewise not reliable. The production man, departmental manager or foreman or workman, should do all in his power to improve matters in this respect.

Direct wages are sometimes known as productive wages; this expression is misleading as wages which are non-productive, *i.e.*, do not help production, either directly or indirectly, should not be tolerated in an industrial undertaking in any circumstances.

Besides direct wages and direct material costs there may be other costs which can be considered as direct costs, *e.g.*, supply of special goods from outside which will form a part of the final delivery, or special patterns or jigs which can be used only for certain works orders, etc.

All these direct costs have to be dealt with separately and their distribution over the cost positions is obviously indicated directly

by the corresponding vouchers. Nevertheless the remark to be found in many publications on costing, *i.e.*, that dealing with direct costs is so simple that no further explanation seems to be necessary, is not justified. This is true only in principle; but everybody who has to do this work in practice knows the many difficulties arising and the great care necessary to overcome them. This is mentioned here expressly because the standpoint of these publications is liable to influence the inexperienced in the wrong direction.

**3. The Allocation of Indirect Costs According to Keys.** Another kind of difficulty must be overcome if the indirect or general costs are to be allocated to the various cost positions. As the name indicates, there is no direct connection to the bearers of costs or works orders which are carried out in the cost positions. For some accounts, as, for example, consumable stores, it may be clear from the vouchers to which cost position they are issued; but there are other accounts or types of cost, where no such connection exists and a "key" must be found as to how the distribution shall take place. These "keys" are the more useful the more they are proportional to the costs to be distributed. For example, the total cost of the consumed electricity can be expressed by the number of units consumed multiplied by the price of the unit. If the distribution of units to the various cost positions is known—a result that could be obtained by inserting a meter at each cost position—the allocation of costs can be done in proportion to the units used during a certain period in the various cost positions. Other such keys are: square feet of area for the distribution of costs of area and one-storied buildings, cubic feet space of building for costs of heating and ventilating, number of working hours of machines for the cost of depreciation, number of men or wages of men for the costs of management and supervision, etc. Where there is no key exactly proportional to the costs to be allocated, an approximately proportional key must be taken; if that also is not possible there is no other way than to use any key which may seem to be convenient.

It may be remarked that it is just this distribution according to more or less suitable keys which renders all costing approximate to a certain extent.

**4. Production Control and the First Allocation of Costs to Cost Positions.** The results of this first distribution of costs to all

individual cost positions separately gives the main basis of "production control" in the widest sense of the word, *i.e.*, including administrative and commercial cost positions. Cost positions are usually selected to correspond with the responsibilities of certain persons, departmental managers, assistant managers, foremen, charge hands, etc. No other costs, more or less outside their direct control, are included with these first distributed figures, and it is only fair to take these, and these alone, as the original guide when judging the activity of these men. As will be shown in due course they are also partly responsible for other additions of overhead costs which will be allocated to the cost positions; but as regards these, other responsibilities are also involved often veiling the final results in such a manner that it is difficult if not impossible to do justice to the responsible man. This should be avoided in all circumstances, as such a procedure easily tends to sow mistrust between the production man and the accountant.

But even if the results of the first distribution of costs to cost positions are alone taken into account judgment of the efficiency of executives is no easy job and the utmost care should be taken when drawing conclusions. One point especially needs consideration: the working conditions are very seldom so similar in two cost positions, that comparison between them is possible even if they seem to be at first glance of the same character, *e.g.*, roll grinding for, or chipping material coming from, two different mills. If that is so in the same works, how much more would it be the case when the two cost positions belong to two different works. It is therefore seldom possible to transfer figures of experience from the one to the other. This remark should not be misunderstood; the value of experience obtained in other similar jobs is not underrated, but the above consideration should lead to the conclusion that the best kind of comparison is the observation of development in one and the same cost position.

An example taken from mechanical engineering may be quoted which indicates the difficulty of comparing two seemingly equal cost positions: a special machine tool was producing a certain work piece in a large mass production works. Piece work wages were established to the satisfaction of management and men. It so happened that exactly the same work piece was used in another part of the works; but the machine tool was unable to deliver the total amount necessary. A second machine of the same kind

was therefore installed in another part of the works. But in spite of all the trouble which the management took, and the good will of the men, they were not able to earn their money with the same piece-work wages. It took a long time before the reason was found : the first machine was installed on the ground floor and the second in the third story of their buildings respectively. The greater vibration of the second machine prevented it obtaining the same results as the first.

Because of the necessity of observing the development of the figures of the same cost position, the cost department should deliver these figures in the form of tables or graphs which can be supplemented week by week, or month by month.

**5. Job Accounts and the Allocations of Costs to Final Cost Positions.** The second purpose of collection, distribution and allocation of costs to the cost positions is to establish a basis for the job accounts. For this reason a further distribution and allocation of costs of the auxiliary cost positions to the main and supplementary cost positions is necessary, because only these latter—sometimes called " final cost positions "—have direct relations to the goods produced. This second allocation is usually done in two or more steps, as some intermediate results may be of interest. For example, the tool room needs electric power for its machines ; it is important to know the total costs of the tool room including these power costs in order to be able to compare in a fair manner the costs of production of a certain tool when made in the shop and when bought outside.

Again there is the difficulty when carrying out this second allocation of finding the best keys : again it must be emphasised that that key should be used which forms the nearest approach to the actual procedure without increasing unduly the clerical work. Thus, for example, the costs of the maintenance department may be distributed according to the actual work the maintenance department is carrying out for the benefit of the individual cost positions. Here again, exactness can be exaggerated, especially as in some cases no other key can be used but one which is to a great extent arbitrary, as, for example, the often used allocation according to direct wages sometimes is.

Here a word may be said about the old dispute, whether it should not be preferred as nearer to the truth, always to use as the key of allocation the men's working time instead of their

wages. From a purely theoretical point of view this question can only be answered in the affirmative, for wages and working time are only proportional in the case of fixed hourly rates ; in the case of piece-work this proportionality no longer exists, *if* the piece-work wages are established and applied fairly. But how often is that really the case ? Is it not often the attitude of the men not to work according to their ability but according to the stipulated piecework wages, thus earning the hourly rate, which forms the basis of the calculation of the piecework wages, and avoiding the " cutting of piecework prices " ? Then, however, the proportionality between time and wages is practically restored. Even in the case of " correct " piecework wages is the deviation from this proportionality big enough to justify the perhaps greater clerical work connected with the allocation according to working time ? The dispute is really " much ado about nothing," and it can be left to individual taste which method is adopted.

## B. REAL AND CALCULATED INDIRECT COSTS

In order to bring this discussion to some conclusion it will be necessary to explain the distinction between " real " and " calculated " indirect costs and to show how to deal with the latter.

*Real* indirect costs are those for which supporting statements such as invoices, requisitions to stores, wage tickets, etc., exist, *i.e.*, statements arising in the usual course of business either inside the works or in connection with outside sources. *Calculated* indirect costs are costs for which such statements are not forthcoming automatically, but must be created specially by the accountant as vouchers for the booking of these costs, because it is believed necessary to include them in the total costs of the products.

**1. Depreciation.**[1] The most important of these calculated indirect costs is what is usually called depreciation. No problem in the theory of " industrial accounts " has been so extensively discussed as that of depreciation and it might be thought that by now everything would be clear, and common agreement arrived at. But when comparing the two main sources mentioned in the introduction to this book it will be found that there is a great

[1] Part of this section has first been published in *The Machinist* of May 28th, 1938.

difference between them on this very question, *i.e.*, how to deal with depreciation from the point of view of the costing system. In order to make this quite clear, extracts from both sources are quoted. The German publication says :—

" Depreciation is the equivalent of the wear and tear of the plant. Goods can be either used, *e.g.*, plant, equipment, etc., or consumed, *e.g.*, raw and auxiliary material, consumable stores, etc. The latter are consumed directly to the full extent for that production process, they are requisitioned from the stores ; the former are consumed in several, sometimes in a great many, parts for production processes of the same number." (Already this consideration shows that there is no difference in principle between the two kinds of goods and that they should be treated in industrial accounts equally in principle.)" He who buys a machine knows the prime costs of the machine ; he knows that some day the machine can no longer be used, but he does *not* know *in advance* for how many production processes he can use the machine ; and therefore neither does he know what proportion of the prime costs of the machine he has to attribute to the individual production process : he can only estimate these proportions according to experience, so that when the machine actually becomes useless some day in the future, the total prime costs—less, perhaps, the scrap price of the machine—have been distributed to all the production processes carried out by the machine. This distribution is what we call " depreciation," and the above consideration shows clearly that depreciation is part of the costs and that no costing system that does not include the depreciation can give the total costs. It shows further that depreciation can be spoken about not only for buildings, machines, etc., *i.e.*, plants of a long life, but also for tools, moulds, rolls, etc. In practice this term is normally used in the first case only.

The economic value of the machine can, however, be diminished, not only by using the machine for production, but also by other influences dependent on the total time since the installation of the machine, such as unreasonable treatment, neglect during long stoppages, destruction by *force majeure*, and particularly by obsolescence. This latter term means that the machine may still be quite workable from a technical point of view, but can no longer be used economically as more up-to-date designs of the

same or similar machines have appeared on the market which will do the same work better or cheaper.

Depreciation is therefore dependent on two influences, the one proportional to the total time during which the plant exists, or, one may say, to the "calendar time"; the other proportional to the number of production operations that have been carried out or can be estimated to be carried out in future, *i.e.*, to some extent proportional to the "working time." The responsible man must decide how he will allow for the influence of these two factors on the amount of depreciation. While the second of them would give a fixed figure for a certain period, say a month, only if the number of production processes does not vary for various periods, the first factor will result always in the same amount per period during the lifetime of the plant. Therefore if a certain number of production processes is estimated as likely for a certain period, and if it is assumed that these would be the working conditions of the plant during its lifetime, thus making the second part of the depreciation also constant per period, it would be necessary to make an additional depreciation for a time of unusually high output.

There has been considerable discussion whether it is correct to use a fixed amount of depreciation per period or not. It has been said that the output of a new machine is more valuable than that of an old one, especially if the output of the latter can only be obtained with higher maintenance costs; it would therefore be more economical to put a higher burden of depreciation on the first years of the life of a machine than on the later ones, *i.e.*, to use decreasing amounts of depreciation. On the other hand, it could be said that the prime costs of a plant are the sum of the depreciation instalments distributed over the lifetime of the machine, but reduced by interest account to the day of the installation of the plant. That means that the amount per year corresponds to a rent, composed by interests and amortisation. The interests decrease with decreasing book-value of the plant, *i.e.*, if fixed depreciation amounts are used per period, it is the same as if increasing amortisation takes place. These considerations show that for the purpose of depreciation the equal distribution of the prime costs of the plant (minus its scrap value at the time of definite shutting down) over the total lifetime is a commendable *via media*.

The greatest difficulty when determining the amount of depreciation is always to estimate correctly the lifetime of the plant."

Here an example taken from the author's experience may be inserted showing how detrimental the consequences can be if a fundamental error is made as to this estimate. A concern which used to assess depreciation on the average at 10% of the original value of its several hundreds of machine tools, to provide for wear and tear and obsolescence, was asked by the inspector of taxes for proof that this figure was correct. Investigation of the books showed that it was not, as the practice of the firm in replacing worn and obsolete machines gave an average life of sixteen and half years for these machines. The consequences were first that the firm had to pay supplementary income tax for a couple of years past on the difference which had been wrongly considered as a part of depreciation and was actually a part of the profit. This additional payment was very high as according to the law the procedure was regarded as fraudulent, and was therefore severely punished. Secondly, obsolescence of the whole machine plant was discovered which made inevitable a sudden and expensive replacement. The result would have been disastrous for the concern if it had not had plenty of reserves.

The German publication therefore reasonably draws attention to the necessity of making sure from time to time that the estimated lifetime coincides with the actual lifetime. Another question is whether one should agree to the consequences envisaged by the same authority in cases where changes in the depreciation amounts are necessary on account of an unexpected technical development.

"If the actual lifetime is longer than the estimated one, and it is not desired to change the plan of amortisation as fixed for the purpose of accountancy, it will be necessary to use different depreciations in accountancy and costing; the latter should correspond to the new estimation of the lifetime, not considering how much of the prime costs have already been written off in the balance sheet. The difference between the figures for depreciation in accountancy and costing has to be booked as "neutral" profit or loss. The total result is therefore not changed, but individual contingencies have been kept away from the costing and this is made more useful for its proper purpose."

What does the " Uniform Cost System " of the British Iron and Steel Federation recommend in regard to depreciation ? " It is recognised that provision for depreciation and obsolescence is a proper charge against cost and that the basis for the determination of the provision for inclusion in the cost requires thorough investigation. Pending such investigation it is recommended that costs shall not include any provision for depreciation and obsolescence, but that for statistical purposes the provision might be entered as a footnote."

And in some other places :—

" Depreciation shall be the amount set aside for the purpose of replacing buildings and equipment when they are no longer considered efficient. *Note.*—This is a memo item only."

The difference between the two publications is evident : both consider depreciation (and obsolescence) as a part of the costs, but the British source refuses for the time being to draw the conclusion from this, because the basis for determining the amount of depreciation has not yet been established accurately enough.

The author cannot agree with this point of view. Of course, as the reader will have recognised already from the extract of the German publication, there are still many questions on the problem of depreciation, to which the answer must be left to the discretion of the responsible man, who may decide differently in different cases. But experience has shown that it is dangerous to omit depreciation entirely when building up costs. It is not enough to say that the people who have to consider costs from one point of view or another know that this omission has been made and will always make a mental reservation when basing decisions on cost figures. On the one hand it is not true that everybody concerned with costs really knows of the omission, and on the other even those who know it are only too easily inclined to overlook it in the daily routine work ; and very serious consequences may be the result. The economic state of the plant, as expressed in the figures of depreciation, should be continually in the mind of all concerned from the managing director down to the foreman, and the cost figures should show him the influence depreciation has on the costs in each individual case. The more he is familiar with these problems, the more care he will take to ensure the economical working of the plant, its maintenance and its well-timed replacement.

It is the production man whose attention should be drawn continuously to these questions : for if production engineers have often pressed too much for new plant of higher capacity, which afterwards turned out to be a failure owing to the impossibility of employing it properly, there are, on the other hand, examples enough of breakdowns of works owing to their plants being obsolete and lack of reserves built up in time for replacement. It is almost impossible to exaggerate the importance of correct, *i.e.*, *just large enough* and *timely*, depreciation, and the inclusion of this item in the costs is a step in the right direction.

This consideration may serve as excuse when the results drawn from the above discussion and from personal experience are once more summarised in the following nine statements, which do not treat the whole problem exhaustively but, it is to be hoped, may be a useful guide in practice.

(1) "Depreciation" in the sense of compensation for wear and tear and obsolescence is different from "depreciation" as often used in published balance sheets, *i.e.*, an item containing secret reserves. If both meanings are used in the same concern some kind of equalisation between them should be introduced for avoiding contradictions in the industrial accounts.

The following points (2) to (9) refer only to the first of these two terms.

(2) It is all the same whether depreciation is based on the prime costs or on the book value of the plant, because neither method can be claimed as absolutely correct, *i.e.*, as always giving the actual value of the plant in question. The first method is perhaps preferable because it is simpler and gives greater stability to the cost figures.

(3) Different percentages of the basic values should be used for the two methods mentioned under (2) so as to obtain similar end values at the same moment.

(4) These percentages are different for different kinds of items, and can be estimated only from experience or may be taken from handbooks if such experience is not yet available in the works in question. The figures taken must be checked continuously, *i.e.*, at least once a year in accordance with experience gained in the meantime, and the necessary corrections must be made in costing as well as accountancy.

(5) The determination of percentages for depreciation is by no

means an easy task which can be done mechanically, say in accordance with some general rules drawn up by the management. On the contrary : the working conditions and the state of repair of every single item of the plant must be carefully taken into account, and that can be done only with the assistance of experts, who are moreover familiar with the special circumstances of the works. Thus it will usually be the best solution if this work is done by close co-operation between the departmental manager, the maintenance engineer and the accountant.

(6) Depreciation has to be taken into account as part of costs in calculating a job, carried out with the machinery in question. The suggestion that no depreciation need be included in costs, if such machinery has already been "fully depreciated" must be considered wrong ; for in such cases either the originally used percentage was too high or the machinery is still working in spite of being obsolete. In the second case sound technical progress would be stopped ; for under such a method of costing the calculation could rarely show that a new plant would be as cheap to run as the old one, *i.e.*, the old plant would never be replaced "for economic reasons."

(7) Depreciation figures should be shown on a special account, which must be carefully watched, so that it is always a true picture of the capital originally invested in the works minus that part of the capital which has already been transformed into products by the use of the machinery.

(8) The actual substitution of new machines for old ones must be charged to this account, except in so far as a machine is replaced by one of higher capacity. In this case the difference between the price of the new machine and the price of one of a capacity of the replaced machine must be charged to a rebuilding and improvement account.

(9) While the basis of the whole calculation is a matter of estimation, *i.e.*, must always remain, even if treated very carefully, an approach to the real truth, the details are afterwards often worked out with the accuracy necessary in accountancy. This results in the belief that the final figures obtained are more reliable than they can be according to the nature of the object and of the method.

**2. Interest.** The second kind of "calculated" indirect costs is interest, or at least that part of this type of costs not actually

paid to a creditor, but which could be calculated as imaginary debts to the original owner of the invested capital. Again there are divergent opinions on how to deal with this item, but in this case the differences of opinion are of a fundamental nature as may be seen by quoting again the British and German publications.

An extract from the German book reads as follows :—

" Interest is the costs resulting from the use of invested capital. It is an expense in the same sense as every other type of costs. Nevertheless opinions are divided whether interest is a part of costs or not. Even if this question is answered in the affirmative there is no agreement about the amount which should be included in the costs as the equivalent of the interest. This difference of opinion can be explained by the fact that the decision may be different according as the problem is considered with regard to the concern as a whole or to that part of the concern which may be termed 'the factory' or perhaps better 'the production departments.' The capitalist puts his money to work in a concern in order to make a 'profit.' This profit is composed of the interest and of the recompense for the risk which is connected with each industrial activity. This distinction is not shown in the balance sheet; the whole is considered as the profit of the concern. But if the works have to work partly with borrowed capital, the interest which must be paid for it is generally considered as expense. For the production departments, however, it is the same, whether the necessary capital is the property of the concern or had to be borrowed from outside. The production uses the capital and has to pay for the costs of this use. This means that the interest on the capital working in the concern is part of the costs, regardless of whether it must be really paid for the borrowed capital or only calculated for the concern's own capital. So far as this calculated interest exceeds that actually paid it is treated in accountancy as "neutral" returns and booked on profit and loss account.

" The amount of the interest per period, say per month, should be calculated according to the book value of the plant and of the stock of raw and of auxiliary material, semi-finished and finished products.

" It would be too lengthy a process to calculate in the interest account the amount of interest for each position ; it is sufficiently accurate to determine the value of the working capital on a

certain day, perhaps the first of the month, and to charge the month with the amount calculated for this capital.

"It is, however, also possible to omit interest from the costs completely and to let the returns for use of capital be merged with the profit and loss account. Of course in this case any difference in the costs produced by quicker turnover of the capital, which is taken into account by charging calculated interest disappears. If the capital is turned over only once a year the profit must contain the amount for the total turnover per year; if it is turned over every month, only a twelfth of the rate of interest is necessary, *i.e.*, the problem in question is of less importance for short term than for long term production where the interest may be a decisive item; but for short term productions also there are more reasons for including the calculated interest in the costs than there are against this method, which may therefore be recommended generally.

"The inclusion of interest for borrowed capital alone should be banned in all circumstances."

In the British publication only one remark on interest could be found, *i.e.* :—

"It is recommended that costs shall not include any charges for interest."

As may be seen from these extracts it is almost a matter of taste which way should be chosen in an individual case, provided there is no common agreement on a standard point of view throughout a particular branch of industry in order to facilitate cost comparisons between different concerns or even productions. If the British publication can be considered as such a standard, well and good; then the problem is solved for the iron and steel industry of this country. Otherwise the author can only express his own opinion that the German deductions do not satisfy him from a theoretical point of view: interest on a concern's own capital is and remains part of the profit according to common sense as well as to the rules of accountancy; those who wish to include it in the calculation of costs for practical reasons may do so; but they should always be aware that the profit they calculate, when for example fixing the necessary selling price for a finished product, represents not the total profit, but will finally be increased by the amount of the calculated interest which they have included in their costs.

Finally it may be added that the rate of calculated interest is best chosen according to the rates of long-term debts as far as the capital invested in plant, machinery, equipment, etc., is concerned and as for short-term debts for that part of the capital which is represented by raw and auxiliary materials and semi-finished and finished products.

**3. Other Calculated Indirect Costs.** There are no other calculated indirect costs mentioned in the two publications cited, but two may be discussed here briefly on account of completeness.

The first are "employer's drawings." This type of cost is of no great importance for the iron and steel industry as it has only to be taken into consideration in the case of privately owned works, which are rare exceptions in this industry. It is understood that what an employer draws from the works of which he is the owner is composed of the recompense for the actual work of management he is doing and the profit he obtains from his invested capital. The first part, assumed to be about the amount of the salary of a general manager in a similar concern (perhaps a joint-stock company), is considered as a part of the costs. Only if this is done is a fair comparison of the costs in a privately owned concern and in a joint-stock company possible. On the other hand, it may be said that it is just this difference which should be reflected in the costs, and that the employer may draw in times of slack business less than the "calculated salary." In this case should a debt of the concern be booked to him? These may be the considerations why "employers' drawings" are generally not included in costs in British concerns, as against the "continental" custom.

The second kind of "calculated indirect costs" referred to above, includes risks of any kind in so far as they are not covered by insurance, as is usually the case in damage caused by fire, water, robbery, etc. In any business risks arise in consequence of deficits which could not be foreseen; perishing of raw materials or finished goods; breakdown of plant; unexpected repairs or replacements of delivered finished goods, where for some reason special payment cannot be asked for; curtailment of profits by suspension of payment; penalties for not correctly fulfilling contracts, etc., and finally the general risk of any employer arising from failure of design, change in customer's tastes, fluctuations in the economic conditions, etc. It is very difficult

to estimate the correct amount which should be included in the costs for these risks ; and that may be the main reason why very often no such provision is made and only a reserve is put aside, if possible, to cover such losses afterwards.

Summarising, one can say that it must be left to the discretion of the responsible man whether he prefers to include " calculated " interest, employers' drawings, or risks in the costs, or to cover them from the profit and loss account. In practice there is scarcely a difference ; for it amounts to the same whether the costs are calculated lower and a higher addition for profit is made, in order to get a certain net profit, or *vice versâ.* In spite of that these discussions on " calculated indirect costs " do not seem to be without value as they show how many items one should take into consideration when building up a costing system in an industrial concern. The fact that often the decision must be left to the discretion of the responsible man in each individual case cannot be altered as long as no authoritative national body has given a standard guide, accepted by the industry. But even such a convinced advocate of reasonable standardisation as the author of this book doubts very much whether accountancy and costing should be made the subjects of standardisation to a large extent. As both should reflect the organisation and the economic state of the industrial concern as truly as possible, and each such concern is an individual with its own peculiarities, standardisation pushed too far, would be contradiction in itself. That may be a difficulty for the accountant, but on the other hand it makes his job so much more attractive, if only he is the right man for " feeling the pulse of life in the works."

## CHAPTER VII

# MATERIAL ACCOUNTS, STORES AND STOCKS

## A. MATERIAL AS COSTING FACTOR

THE purpose of each industrial undertaking is the transformation of raw material by labour into saleable goods. It is obvious, therefore, that material and its economy is of essential importance to the profit and loss of the concern. Especially is that the case in iron and steel works where, as already mentioned, material forms a comparatively high percentage of the costs in contrast to mechanical engineering, for example, where labour costs have a larger influence.

In spite of this fact, it is not unusual to find the organisation of the storage of material of any kind in a state which would not be tolerated in the case of labour problems. The reason may be that the connection with money is not so obvious, and that, especially in metallurgical works, the quantities of material to be treated are so enormous, and the price per unit often so low, that waste does not seem to be significant so long as no precious metals or the loss of big quantities come into question.

This point of view, however, is wrong, and the understanding of this fact is certainly growing ; the "good old times," when it did not matter whether a waggon of scrap or pig iron more or less had entered the works and was charged in the books, when even leading persons openly declared there should be one or more such waggons in excess in the works "as reserve," are definitely gone, and greater attention is given to all questions of organisation of material storage.

## B. THE STORAGE OF MATERIAL

**1. The Purpose of Storage.** Material management problems can best be understood if the purposes of storage are clear. They should be so to everybody from his experience in daily life ; but when applying these simple ideas to industrial matters, so many

mistakes can be found in practice that it seems to be worth while to mention the main reasons, why a well-organised storage system is an indispensable necessity for an industrial works. Normally only by the use of such a storage system is it possible :—

(1) To buy material in bulk, *i.e.*, at reduced price, for re-issue in small amounts and to ensure at the same time that the stock level remains within economic limits.

(2) To make certain that material is always available when needed even if long times of delivery are demanded by the supplier.

(3) To review thoroughly the economic situation in the works and establish effective production control.

**2. The Quantities to be Stored.** These three points of view—quantities, time, and costs—hardly need further explanation at first glance, but the problems are so intricate that the greatest care by the management is necessary in order to avoid mistakes, which may be detrimental to the whole concern.

The difficulty is that the approach to these problems from a theoretical standpoint has scarcely proved possible. We find many attempts in this direction, especially in the American literature, but experience has shown that the cases where one or other of the nice formulæ developed in the office can be used in practice are so seldom that they are better not considered at all.

One should know that the storage of excessive quantities is connected with all the losses which follow excessive investments ; that, on the other hand, stores in too small quantities bring about the danger of shortage just at the time when the material is urgently needed ; and in steering between these Scylla and Charybdis there is, properly speaking, nothing more than " common sense " to guide. Perhaps some help can be drawn from former experience in the same works, and from past statistics ; but even that may be misleading if the working conditions, especially the degree of activity in the works, are different from those of the period in comparison. Thus the only guide which can be given generally is, perhaps, that the storage should be done with a certain margin of safety, because the disadvantages of " too much " are smaller than those of " too little." Further, the more the modern tendency of a continuous flow of work can be realised through the work, the smaller can and should be the storage of material.

It is no secret that a great deal of the success of Henry Ford is due to a careful consideration of this fact ; and it has to be taken as a favourable circumstance that most processes in iron and steel works are of this nature of continuous flow.

Another point worth mentioning is that care in managing stores of these works should not be exaggerated to an uneconomical degree. What is meant by this remark may best be illustrated by an example : Hundreds of waggons of ore, coal, scrap, pig iron, etc., arrive daily at one of the great iron and steel works ; they are driven slowly by a locomotive over a weighbridge, stopping for each individual waggon to determine the gross weight before unloading at the proper position. So far, so good ; but now the empty waggons are again driven back over the weighbridge to control the tare, which is painted on each waggon. Certainly differences will be found ; they may be due to changes in the weather ; but the question arises whether the costs for the loco-service, for the men at the weighbridge, for all the clerical work connected with this procedure, etc., are not greater than the possible gain which could be obtained from reclamations because of differences in the net weight. Perhaps it will be sufficient to take samples off-hand from time to time or when there is any reason to suspect something wrong.

**3. The Subdivision of Material to be Stored.** We have to distinguish between :—

(1) Direct material, *i.e.*, raw material transformed into goods in the works by any of the manufacturing processes and contained finally, at least to the greatest part, in these goods.

(2) Indirect material, *i.e.*, material used and consumed during production.

(3) Finished material or saleable goods.

These distinctions cannot be applied to a particular material in general ; on the contrary, they can only be used from the point of view of the works in question—*i.e.*, what belongs in one case to one of these groups may, in another case, be part of another group ; but it is necessary for costing purposes to make this distinction clear once and for all in the particular works ; and where, as it sometimes happens, a change takes place from one group to another, to provide for special measures of transferring so that correct book-keeping takes place. In order to make these remarks perfectly clear, round bars may be saleable goods for the

works in question, and so stored in the warehouse, but for some repairs such bars are needed and have to be transferred to the "indirect material" to an extent necessary for the repair.

Special attention must be given to material which arises from the production process and is known as scrap, by-products, etc. Scrap has to be collected immediately after it has appeared and brought to the scrap dump where it belongs, after being credited to the order or workshop where it arises. The calculation of by-products is similar, but here arises one of the most difficult questions of costing which can only be solved in a special case, and even then mostly by an agreement between all concerned, because there is no solution which could be considered as absolutely correct from all points of view. This problem will be discussed later in detail.

**4. The Arrangement of the Stores.** Here, too, it will only be possible to give some general principles, as all details are to be adapted to the special nature of the material to be stored.

The question whether an *open* stockyard accessible to everybody, or a *closed* stores or warehouse, should be chosen will be decided according to bulkiness, weight and value of the material. It is clear that the latter form is the better one from an administrative point of view, as it is easier to keep the survey of what is at hand when only a limited number of persons responsible for the material has access to it. Therefore the former arrangement can be allowed only where the danger that unauthorised people may cause disorder or remove material without voucher is excluded by the nature of material, as is the case with ore, scrap, ingots, etc. It may be expressly mentioned that these remarks are based less on the fear of loss by theft—in many cases this loss would be less than the cost of supervision of the stores—than on the fact that "open" stores make the necessary survey and book-keeping nearly impossible in many cases.

**5. Stores Administration and Control.** A much-discussed question is whether the actual *administration* of the stores and the *control* of the stores by suitable book-keeping should be in one hand or strictly separated. It is clear that, in principle,
the separation can be right, because nobody's work
controlled by himself. Experience has shown, how
are cases in practice where it can be re
through this practice, and the problem

tion and control of the stores may prove to be one of these exceptions. One must, of course, disregard any question of ill-feeling on the part of the storekeeper, who may look at such a separation as a sign of distrust : everyone in industry has to consent to being controlled. But the combination of proper storekeeping and book-keeping sometimes brings about such an intimate knowledge of the requirements of the works concerned that each of these two activities alone will never produce. That, however, can be a real asset, especially in stores of great size with perhaps thousands of various parts where " drugs in the market " only too easily arise which a careful and experienced storekeeper could avoid.

This is certainly one of the occasions where it is evident that the persons in the works have not to be used according to its organisation, but the organisation built up according to the persons available. One may decide for combination in a certain store, but reverse this decision when the storekeeper retires and an adequate substitute is not available.

If separation is decided upon, one mistake—unfortunately found frequently in practice—should always be avoided. In spite of the separated book-keeping a rump-book-keeping is arranged in the store itself which is sometimes considered an intensification of control without being so in practice. The result in this case is enlargement of clerical work, not only by duplication but also because the two books or cards dealing with the same object must be made to coincide if a discrepancy arises. Thus it can often be observed that in addition to the book-keeping of the stores—at present nearly exclusively carried out by card indices—the " bin cards " in the stores are continued, which contain nothing more than some of the items on the cards in the store book-keeping, in both cases based on exactly the same vouchers. Good experience has been obtained by suddenly scrapping these bin cards after the separated store book-keeping was put in good order. One cannot object that the storekeeper then has insufficient survey of the contents of his store ; he has
looking into the bins. But he is deprived of the possibility
lly making the actual stock coincide with that on
thus real control by the store book-keeping is

ministration may be mentioned, the

negligence of which often leads to trouble and sometimes even to booking the same material twice. Any purchased material should be charged to the stores and issued from the stores but not immediately charged to a special order, even if it is actually brought to the spot where it is to be used because of its bulkiness or because no other purpose of use is possible.

**6. The Stock in the Stores.** It has been mentioned that the greatest attention must be given to the quantity of the " stock " in the stores—*i.e.*, the difference between the material received and issued, or the material remaining in the stores. Attention may be drawn here only to one other detail: this stock is not always really available for any new order, because it is possible that it is already partly seized by previous orders not yet sent to the shops. Distinction should therefore be made between the " real " stock at hand in stores and the " available " stock which is free for new orders. Simple as this idea is theoretically, it is sometimes difficult to carry out in practice. In any case, careful organisation and an especially close connection between the " order book," the department of production planning, and the stores book-keeping must be made. This should be done, therefore, only where it is really necessary to avoid delays in delivery, etc.; but it is sometimes found that it is done more generally in order to avoid different forms for the two different kinds of material: the same form being used in both cases is taken by the employees concerned as an instruction to proceed equally in both cases. This remark may seem to be far-fetched, but it is not superfluous to draw attention to such incredible facts going on for years until mere chance brings them to light.

## C. THE ORGANISATION OF THE STORES

**1. Generally.** Industrial works can be likened to a body of organic structure, and as there are no two human beings, two animals or two trees absolutely equal to each other, so there will never be two industrial works which could be considered identical to the last detail, even if their original plans on paper could not be distinguished from each other. Surroundings, working conditions, peculiarities of the people working in them, and many other influences will soon bring about a special individuality which in turn needs the application of arrangements especially fitted to the works in question, if an efficiency of work as high

as possible is to be obtained. That is what so many "organisers" of industrial works overlook: the organisation to fit accurately to this body of organic structure can never be "ready made"; it must be "made to measure." Therefore it is impossible to define clearly the position of the stores in the organisation of the works, and all that can be said on this problem should only be taken as an example of how this question is answered in a special case and what advantages and disadvantages are connected with the solution adopted. Thus it is often discussed whether stores belong to the technical or commercial side of the undertaking and whether they should therefore be subordinated to the works manager or to the commercial manager. The author has found that the answer depends in practice mainly on the characteristics of the persons concerned—another instance that the personality of the people at hand determine the kind of organisation, and not *vice versâ*.

Economic reasons, however, seem to demand nearly always that the management of the stores should be independent of that of the production proper. To a certain extent the stores control production, as far as the economical use of raw material, the delivery of finished goods, etc., are concerned; a co-ordination at least of the stores manager and the individual managers of the production departments would therefore be the correct reflection of their relations to each other. That does not imply any contradiction to the fact that the stores are bound to work in close co-operation with production, to which they have to work as the supplier to the customer; for it is well known that in this case the best results will always be obtained if the negotiations are conducted on equal terms.

**2. Requisitions and Returns to the Stores.** Now we come to a measure which one hears so often referred to as "red tape," and which must appear at first glance to the inexperienced mind really to be so.

*Nothing should be taken out of the stores without a regular requisition slip.* How often does one hear complaints about the unnecessary paper-work for a few pence, about all this work, "only invented by clerks in order to provide work for themselves and to show their own importance!" But it must be emphasised that without carrying through this demand strictly no real survey of the economic situation of the works, no orderly book-keeping

and correct profit and loss account, is possible. The author knows that even here exaggerations occur, but it is the "rule of large figures" which should be kept in mind, the fact that the sum of numerous small items is finally a lot, and these items easily run up in big works to many thousands a week. There is no other way than the demand of requisition slips for each item; and what makes things worse, there are many cases where the stores must deliver, for technical reasons, more than is asked for, and a return of the excess with a return slip is unconditionally needed. Naturally, the whole procedure should be made as easy for the workshops as possible by suitably printed forms, by correct situation of and clear arrangement in the stores, etc., but that is nearly all that can be done. The fundamental demand, as already explained, cannot be abandoned.

The next stage in treating these requisition slips is the evaluating of the material, the voucher for which they are. There are in use various methods for this work:—(*a*) To take the actual value of the material, as shown by the invoice in cases where the material is delivered from outside, or by calculation when produced or transformed in the works; (*b*) to choose the "market price"; or (*c*) to fix a "standard value" unchangeable for a certain time, perhaps the business year. The author prefers personally the method under (*a*), especially because it can be reasonably explained to the employees concerned as following closest the actual course of events, but it cannot be denied that the other methods have advantages, which may lead to their application—*e.g.*, in case of great fluctuations of the market prices. One may even find, in the same works, the use of two or three of these methods simultaneously for various types of material, and has to agree that some advantages could be accomplished only in this way in the case in question. Of course, that means a more careful training and supervision of the employees concerned. But, whatever method is adopted, it should never be forgotten that carefully as it may be carried out the right result can only be obtained if the original vouchers, the requisition and return slips, are correctly written out and correspondingly carried out, and it is here that many queer mistakes often occur. The employees who have to do this work cannot for economic reasons be highly trained, and easily become accustomed to do their work mechanically. It is the duty of the storekeeper to

supervise them continuously, and to eliminate such mistakes as using wrong lines or columns in the printed forms, by confounding the various figures, writing words or figures incorrectly, etc. These minor matters often cause trouble in an organisation, the main feature of which may be absolutely sound. The planning of an organisation is comparatively easy, but it is its application in connection with all the detail work which matters in practice and decides whether the organisation is a real success or not.

In order to obtain a better understanding what these considerations on stores and their organisation actually mean it will be of interest to discuss in detail how the stores are connected with other departments of the works. For this purpose it will be convenient to follow an example how the flow of the material into and out of the stores is carried out and of the clerical work which must be done in order that a complete report on this flow is available.

**3. Material Received in the Stores.** All material from outside sources is received at the receiving depot, either actually, when the nature of the material allows, or for booking purposes only, when the bulkiness or the nature of the material (ore, scrap, etc.) forbids intermediate storage in the receiving depot.

In the latter case, precautions must be taken to prevent the material being used before permission is expressly given, according to the organisation to be described. This is an important point which is often neglected. It must be admitted that this instruction is not always easy to carry out, but disregarding it may endanger the success of any objection raised to the acceptance of the material received.

In the office of the receiving depot seven copies of the receipt are made, using suitable printed forms, according to Figs. 11a, b and c. They are so arranged that the particulars on all copies are produced on a typewriter at the same time as the original is made. As may be seen, copies 1 and 2, on the one hand, and copies 3 and 4, on the other hand, are each called "preliminary receipt," copies 5, 6, and 7, "definite receipt." The differences between printed forms will be explained subsequently by their use in the various departments. The course of the copies is illustrated by Fig. 12.

Copy 1 (Fig. 11a) is sent to the purchasing department for quick information, in order to prevent unnecessary correspondence

with the supplier. Later it is sent together with the supplier's invoice to the book-keeping department, *i.e.*, the department where the books of accountancy proper are kept, and then returned to the purchasing department for filing. Copy 2 (Fig. 11a) is sent to stores control for the quick information of the ordering department. Copies 3 and 4 (Fig. 11b) are sent to the

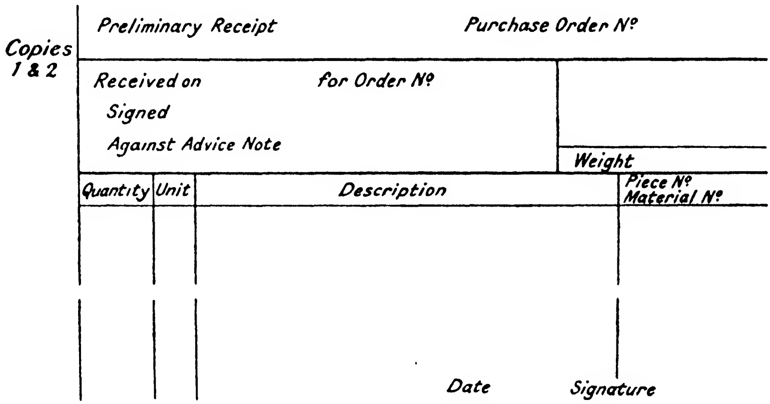


Fig. 11a. Receipt of material,

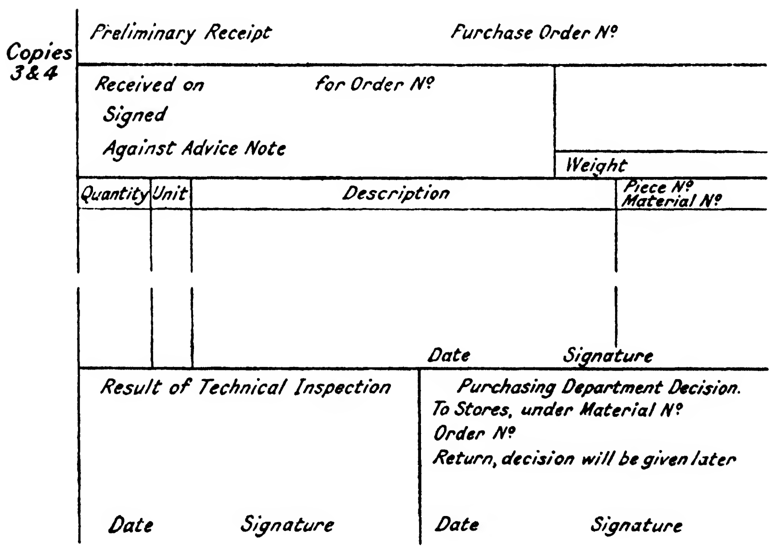


Fig. 11b. Receipt of material.

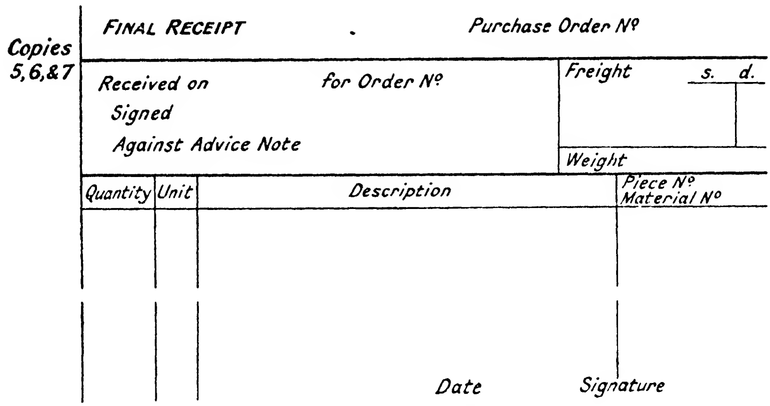


FIG. 11c. Receipt of material.

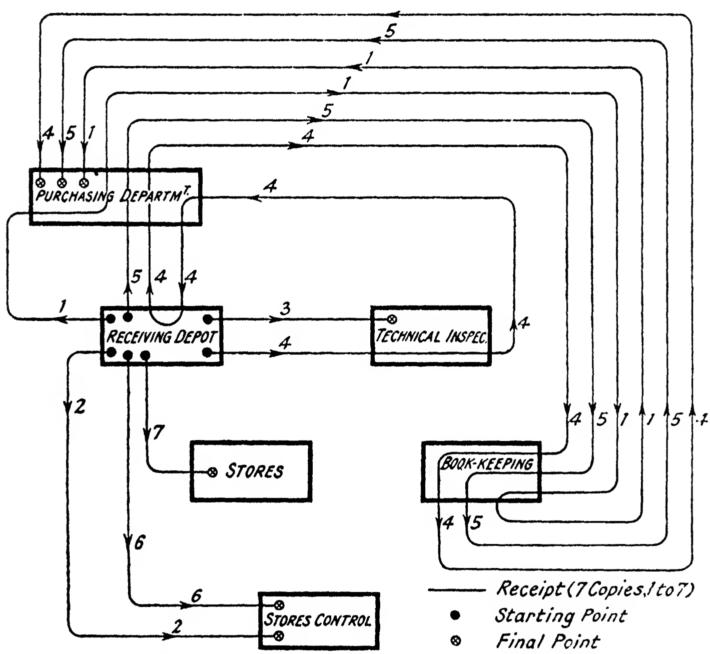


FIG. 12. Showing the course of the forms reflecting the receipt of material in the stores.

technical inspection department, which retains copy 3 for its files and sends copy 4 to the purchasing department, after having made the necessary tests and entered the results on this copy.

The purchasing department decides whether the material can be accepted, makes this decision on copy 4, and returns it to the receiving depot. Here copies 4 and 5 are fastened together and sent to the purchasing department for comparison with the invoice of the supplier. Copies 1, 4, and 5 and the invoice are then sent to the book-keeping department, which returns the receipts 1, 4, and 5 to the files of the purchasing department. Copy 6 is sent with a copy of the invoice to stores control, copy 7 to the stores themselves.

It must be admitted that this organisation seems rather complicated at first glance ; and the author is the last to recommend it for every possible instance, but the reader can be assured that it has proved effective in various and very different industrial works, that it entails comparatively small clerical work, and presents, simultaneously, sufficient safety against carelessness and fraud. Special attention may be drawn to the fact that the receiving department must write down the receipt according to the actual material, as no advice note or supplier's invoice is at hand when the material arrives ; thus it is impossible to "copy" the supplier's invoice and regard it as a receipt, as lazy receivers of the material are sometimes inclined to do. Another point of view worth mentioning is that no further co-operation of the supplier is expected, as for instance the sending of the invoice in duplicate. Experience has shown that any organisation which seeks the special co-operation of an outside firm is, to a certain extent, unreliable.

Finally, it may be added that *returns* of any kind are treated in the same way as new material ; in these instances the intermediate storage in the receiving depot is very important, and, if possible, this practice should be adhered to so that a close inspection of the returned goods is possible before they are accepted by the stores.

**4. Material Issued from the Stores.** As already explained in requisitioning material from the stores, there is a distinction between material in stock. Part of the stock can and should be reserved for orders already received, but on which work has not begun ; thus the material in the stores may comprise "actual" stock and "available" stock and may require to be separated in the stores book-keeping. On the other hand, however, such a separation may be superfluous or even absurd. The former will

always be "direct" material, the latter either "direct" or "indirect" material. Both kinds of material are demanded from the stores by requisition slips of the same printed form, but of different colour. Requisition slips for direct material are generally made out by the planning department, those for indirect material by the consuming section; an original and one copy are provided, each having the same current number, so that all slips can be traced and controlled.

The course of the material issued from the stores, and the clerical work connected with it, is illustrated as example by

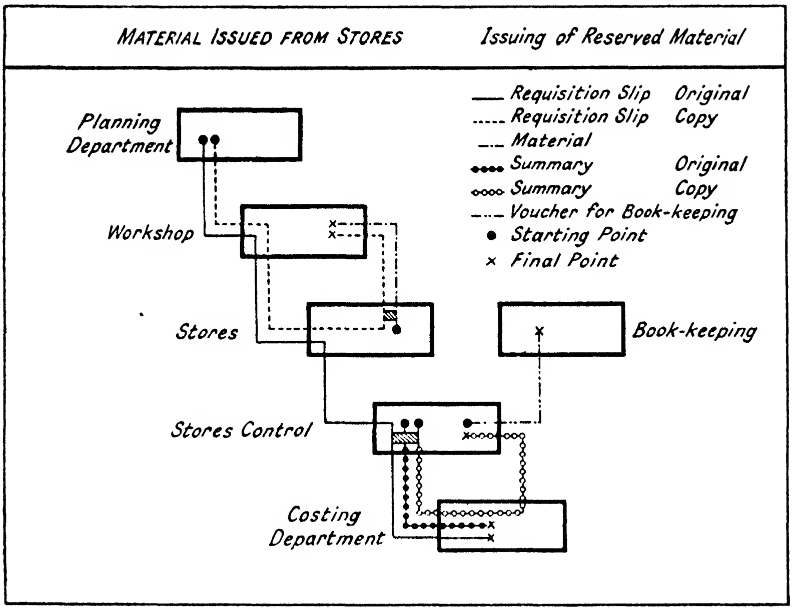


FIG. 13. Showing the course of materials issued from the stores.

Fig. 13 for "reserved material"—*i.e.*, where it is decided to distinguish the material by "actual" and "available" stock. The scheme for "not reserved" material can easily be determined analogously to Fig. 13.

The planning department makes out the requisition slips and sends the original and the copy together to the workshop, which in turn forwards both to the stores. From the stores the copy of the requisition slip travels, together with the material in question, to the workshop, while the original is sent to stores control. In

the stores control all necessary details are entered into a card indexing system, which can be regarded as the key to the information about each material issued from the stores, and must, therefore, be very carefully kept.[1] This point will be discussed later. After the evaluation of the issued material and entry of the value on the requisition slip as well as in the card index, a summary is prepared and made out in duplicate. This can consist of a daily or a weekly summary, according to the number of the issue items, and the originals of the requisition slips with both copies of the summary then travel to the costing department, where they are examined, mistakes corrected, and failures rectified. The current numbers of the requisition slips provide a guide for the latter purpose.

When the copy of the summary is acknowledged as correct, it is returned as a receipt to the stores control and a short voucher informs the book-keeping department of the necessary figures to be taken from the summary. Thus, the book-keeping department receives daily or weekly figures for entering into the accounts, instead of figures for each detail, but the auditors can easily trace back the origin and composition of these figures to the single requisition slips, where they consider this to be necessary.

The requisition slips are collected, according to the order numbers, in the costing department, so that the consumption of the material can be determined for each order separately. This does not mean that the determination should be made for all orders ; on the contrary, in many cases it has been proved that a complete calculation of all finished orders is unnecessary, as the advantage gained does not compensate for the amount of clerical work involved, but the costing department should be in a position to collect easily the costs of any order which the management may select for any special reason. This problem will be discussed later in detail.

**5. The Card Index of the Stores.** A few remarks may be added about the work of the stores control, or rather its main tool—the stores card index. How it works may be gathered from Fig. 14, which shows only the head of the cards and scarcely needs a detailed explanation. It gives *as an example* the printed form of a card, which may be used for " reserved " material and would satisfy all demands which can be put to such a *document*. For

[1] See Stocktaking, pp. 12 to 17.

| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IRON STOCK | | | | Description | | | | Piece no. | | | | Average consumption | | | | To be available | Minimum | | | | —piece lb. | | | Stores | Shelf |
| Piece lb. feet | | | | | | | | Material no. | | | | | | | | | Maximum | | | | feet | | | | Bin |
| Received | | | | | Issued | | | | | In stock | | To be reserved | | | | Remainder available | Demand reported | | | | Ordered | | | Become available | Reminder |
| Date | Voucher number | Quan. | Price of unit-sh. | Total price | Date | Voucher number | Quan. | Price of unit-sh. | Total price | Quantity | Total price-sh. | Date | Voucher number | Quan. | Date of issue | Quan. | Date | Quan. | Demand slip number | To be delivered Quan. Date | Date | Quan. | Order No. | Quan. | To be delivered Quan. Date |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | | | |

FIG. 14. The card index of the stores.

example: one card is used for the type of material concerned, and the sum of all cards make a continuous inventory of the whole material existing in the works if—and this is essential—the cards are used and filled in properly. That is the important and difficult duty of all concerned with stores control, and the superintendent and his assistants must look after the correct working of this apparatus incessantly; for, as already mentioned, mistakes too easily creep into these details, which, though small in themselves, may add up to amounts which make illusory the necessary survey, without which the management cannot lead the undertaking efficiently.

The foregoing explanations may be sufficient to convey a right impression of the position occupied by the stores in the organisation of the works. It will be appreciated that the explanations are not by any means exhaustive; what is hoped, however, is that these examples show the spirit in which these matters should be approached and dealt with.

## D. LAY-OUT OF THE STORES

To discuss the stores as part of the lay-out of the works in a general way presents many limitations, since less can be mentioned than can be considered to be

generally correct. It is proposed, therefore, to confine the discussion to the problem of centralisation or decentralisation of the stores.

It is obvious, from an administrative point of view, that the centralisation of the stores has great advantages, and therefore one can generally find an inclination towards this form. It must, however, be considered that, especially in iron and steel works where mostly large areas are covered, centralised stores easily increase the transport costs to an inadmissible amount. It is often difficult to find out whether this point is actually reached, because the determination of the actual losses by excess of transport is not an easy task and generally includes a mere estimation of some costs in addition to those which can be calculated. When looking for a suitable compromise, it should always be considered that administration is a service the demands of which must be secondary to those of the main work, especially if the latter is connected with such high costs as transport generally involves.

When the transport costs from a central store are likely to be excessive, two or more stores for the same material may be located in various parts of the works, and a new and difficult task of stores control arises. It is necessary to assign the right proportion of material to each individual store, to equalise stock, when issues from one store have been excessive, to consider all stores together when ordering new material, etc. The usual method of maintaining balance between the various stores is to use an individual card for each store and a main or summary card for all stores together; this certainly involves additional clerical work, and difficult clerical work too, but only rare cases are known where it could be avoided with advantage.

In any case, it is important to guard against measures of distribution which allocate weekly or even monthly consumption of certain material to the foremen—*i.e.*, building up "foremen stores," which have to be made good according to the quantities issued to the shops. Although, at first glance, this idea seems to be very promising, it cannot be too strongly pointed out that in practice the method is bad. The control of these numerous small stores becomes so difficult that often it is entirely omitted and the necessary survey is lost. The author could tell from his experience convincing examples, where material of a value

amounting to hundreds and even thousands of pounds had disappeared from the books, and was found only after many months ; material which was badly needed in other parts of the works.

Whoever believes that such or similar conditions are impossible in his own works may be congratulated wholeheartedly, but the author, as a result of his experiences of industrial practice, is usually somewhat sceptical of the accuracy of such statements.

## CHAPTER VIII

# THE WAGE ACCOUNT

THERE can be no doubt that however important other working conditions may be in forming the relation of the men to their firm, the wages problem will always be the most significant—and rightly so. If an industrial undertaking has succeeded in building up the wage system in such a manner that a fair compromise has taken place between the demands of the management and the men, and if this system is applied so that the men, consciously or unconsciously, feel this fairness, much, if not all, is gained for real co-operation, so important for the prosperity of the firm.

## A. THE DEMANDS ON A WAGE SYSTEM

What now are these demands which the management on the one hand and the men on the other hand may rightly put to a wage system? Before making an attempt to define these demands, it may be useful to point out that we do not speak in this connection about the *absolute* amount of money which has to be paid to the man for a given time or certain work, but about the *relation* of the figures for different work or different men.

The management has an interest in the system which is covered by the following :—

A1. The calculation of wages should be as simple as possible.

A2. The value of a certain piece of work should be capable of determination beforehand.

A3. The amounts of wages for different jobs should be proportional to the difficulty of work involved.

For the men, it is important that :—

B1. They should easily understand how their earnings are built up.

B2. The fluctuations in their earnings should be tolerable.

B3. Different men with different earnings should have their earnings graduated as far as possible to the difficulty of the jobs and the ability and industry of the men.

This summary, which only gives the main demands, shows that if we, for the moment, disregard the absolute figures, the demands of the management and the men on a wage system are nearly identical. The best known and most-used wage systems are the fixed hourly rate and the piecework rate ; all others are more or less built up on one of these two or a combination of both. It will, therefore, be useful to consider these two systems separately and more in detail.

**1. The Fixed Hourly Rate.** This is the oldest, but still very much used form of wages, and the author is convinced that the development of modern industry will again bring about preference for this form, after it has been tried as an emergency measure in cases where other "higher" wage systems could not be used. The calculation of the earnings of the man is so simple in this system that it needs no explanation : the time the man is in the works is multiplied by the fixed hourly rate. It will be clear that the demands A1, B1, and B2 are fulfilled perhaps as completely as possible. But as no really direct relation exists between the rate and the work, neither demand A2, nor the nearly identical demands A3 and B3 can be fulfilled.

On the other hand, it has to be considered that the development of the industrial technique is certainly directed towards relieving the worker from manual work and in making him the leader of machinery which does the actual work. As the most highly developed example, consider a modern power station, where the work of the men is almost completely reduced to the observation of measuring instruments and the moving of certain levers and switches. (In order to avoid misunderstanding, it may be expressly pointed out that this has increased rather than lowered the importance of the man's work.) Or consideration may be given to the high-production technique developed, for example, in Henry Ford's factories, where the equipment of the shops, especially the transport system, determines the speed of the work, and therefore rules out any other wage system. In addition, the fixed hourly rate is used in other industries where the nature of the work forbids or makes it impossible to predetermine a certain time for a given job. This is largely the case for repair work, where, too often, during the work itself, unforeseen jobs must be carried out, and the interests of the firm are best served when the men are not unnecessarily hurried in making a thorough and good repair.

In such cases it is generally uneconomical to give the men a special incentive to speed up repair work: the machines which have to be repaired, either after a breakdown or in the form of the periodical overhauling, are usually so valuable that a longer time, and therefore more costly repair, does not count if thereby a real improvement in the state of the machine is reached or the danger of a repeated and perhaps more serious breakdown is avoided. The same applies in the case of work which needs special care or attention, as, for instance, inspection work and the making of tools, jigs, gauges, etc. It would be foolish to endanger the result of work, perhaps many times as costly, by hurrying the inspection and thus saving a small part of its costs. Further, in modern industrial works, the work of one shop or department is frequently so dependent on that of another that this very fact provides the men with an incentive to repair the machine in question, or to deliver the necessary tool or gauge, etc., as quickly as possible, as they know that their colleagues are waiting for it and will perhaps experience losses if undue delay of the necessary repair occurs.

It cannot be denied, however, that our demands A2, A3, and B3 are not fulfilled, and that the nature of the fixed hourly rate system does make it nearly impossible to fulfil them. As these are very important demands, it is only natural that efforts to overcome these difficulties should have been made by another wage system. That may be the origin of the piece-rate system.

**2. The Piece-rate System.** A closer connection between the amount of payment and the amount and quality of work done is required, on the one hand, because it seems to be fair, on the other hand, because it is important, sometimes even vital for the management to know beforehand the actual costs of a job. Again, let us remember that we are dealing with the problem from a *practical* point of view. We are well aware that a certain school of thought, the purely socialistic one, declines this connection between wage and work but to treat this problem is outside of the scope of this book.

This demand that the wage paid and the amount and quality of work done should be proportionate to one another is perhaps one of the most difficult to fulfil in industrial practice. The most experienced specialists agree that this problem is by no means completely solved or that it can be solved under our present

knowledge of human physiology or psychology. But that does not relieve us from the obligation to attempt its solution as far as possible. The difficulties involved in, and the imperfections connected with, applying this idea in practical cases may perhaps best be understood by considering how this problem has been treated in the course of time.

Originally the foreman of a shop was asked to fix a piece-work rate for a certain job. He "guessed," according to his experience, how long a man would take to do it, perhaps thirty minutes, and as this man earned on the average 2s. per hour, he fixed the piece-work price at 1s. The man, of course, contradicted and explained that he needed fifty minutes, and after a certain discussion they agreed on forty minutes, and the piece-work price was fixed at 1s. 4d. It is from this imperfect method of rate-fixing that this wage system is sometimes termed "accord system."

Our example is certainly crude, and in this form may not occur in practice to-day, but if one goes to the root of the method applied, this kind of guesswork is more prevalent than is imagined, although it is veiled in one way or another, and therefore not so obvious to the critical observer. But why do we condemn this method so sharply? Experience shows that seldom is pure guessing correct. Either the price obtained is too low and trouble is encountered with the man, who cannot earn the money he believes himself entitled to; or the price is too high and the man earns more than the foreman expected. The latter protects himself by cutting down the price, one of the most objectionable procedures in the system, because it destroys the confidence of the men in the management, as any breach of promise is bound to do; or the man, who has learned his lesson by former price-cutting, slows up his work in order to earn just as much, or only a little more, as has been expected. Both parties, management and men, suffer a loss.

Perhaps there are some piece-work prices in the shop which are too high, and some which are too low, in the sense explained above; it is possible, however, and indeed usual, to draw a veil over the whole procedure by mixing these "good" and "bad" piece-work prices—to use the normal workshop expressions—in such a manner that the mistakes made do not come to light. Even the foreman sometimes favours this proceeding, either because he fears the objections of his superintendent for fixing

wrong prices, or because he wants to avoid trouble with the men.

It may perhaps be said that the actual conditions in practice were not so bad as described; but whoever has occasion to investigate various industrial works, or to discuss this matter with colleagues in other undertakings, knows very well that though such conditions have perhaps ceased to operate in the factory of any individual reader of these lines, they are, nevertheless, often customary, he may believe, in other works. Certainly, however, it should be clear that such piece-work prices do not fulfil our stipulated demands: they neither give in advance a true picture of what a job will cost, or, better, *should* cost, nor are they really, or at least approximately, proportionate to the amount or quality of the work to be done.

In order to avoid the mistakes explained above, it is primarily necessary to entrust the difficult work of piece-rate fixing to a man who can devote to this job more time and thought than the busy foreman can afford. This step is taken frequently, and the "rate-fixer" has made his appearance in industrial works. Unfortunately, it is sometimes believed that that is enough, a belief which is definitely wrong. If this man works according to the old method, no improvement takes place; very often indeed there is deterioration, as his connection with the shop is not so close as that of the foreman. Much more important is that he should use different methods of rate-fixing, such as estimation based on careful works analysis; calculation where it is possible —*i.e.*, where the working time is governed by machine and not by hand-work; work and time studies on equal or similar work in the shops themselves; comparative and statistical methods by means of tables and graphs; all closely adapted to the present working conditions or those that can be expected in the future, when proposed alteration or further development has taken place.

It is not possible here to consider in detail this important work, of which mention has so far only been made from one point of view; the reader seeking more enlightenment must be referred to the extensive special literature on this "science," which has been developed during recent years. Attention should be drawn, however, to one point: it is not a "science" in the accepted sense of the word, for there are too many basic facts still insufficiently investigated, and too many empiric values must be used;

but it can be stated that sufficient is known to develop in practice methods which avoid many of the mistakes of the old method of rate-fixing and which give sufficiently fair figures for the working times of various jobs.

Up till now we have been concerned with the determination of time; there is a second and not less intricate problem, the transition from time to money which remains to be made.

This seems to be so simple, in view of the various agreements with the men's organisations. For nearly all the various positions of the workmen in each trade hourly rates are fixed, and a special clause makes it clear that if the work is carried out against a piece-work price, the men are entitled to 25%, 30%, or 33%, etc., in excess of the earnings on a fixed hourly basis. In such cases it is only necessary to increase accordingly, and the desired money factor is found with which the working time must be multiplied to obtain the right piece-work price. This is the usual way and may be the best way under present conditions.

The author would like to point out, however, that injustice and unfairness can easily creep in, and for the time being perhaps it cannot be avoided; it may be desirable therefore to give this point more detailed consideration. The social conditions between employers and employees have often been so developed that the agreements previously mentioned are considered from the one side as a maximum and from the other as a minimum of the demands of payment; and they have thereby obtained an inflexibility which makes it nearly impossible to take into account the variations of difficulty between jobs belonging to the same heading of the agreement. Various methods of avoiding this difficulty have been applied in practice which, being outside the scope of this book, cannot be discussed here in detail, but they have been applied sporadically, and a more systematic treatment of this problem seems to be worth while. Certainly it will take much time and work before the basic facts are clear and before their practical application will be possible; these short hints, therefore, may only be considered as attempts to draw attention to a problem which is often completely overlooked. That seems the more important, as these remarks also apply to the fixed hourly rate system.

One point, however, must be emphasised before leaving the piece-work wage system. After a piece-work price is fixed in the

manner previously explained, it should be changed only when an actual error has been made, and then only after it has been openly discussed with the men and agreement is obtained, or when a clear change of the working conditions has taken place and the basic factors of the fixed price have been altered. The bad method of " price-cutting " must disappear to preserve good relations. Only when this rule is strictly followed and the men have the confidence that they will be treated fairly, is it possible to prevent that unpleasant behaviour of the men, which production engineers know only too well as slowing down working capacity, a kind of passive resistance, which men use as a weapon against unfair treatment. In such a case the men no longer work as they *can*, but as they are *expected* to work by the rate-fixer, and an equalisation of the hourly earnings takes place, which nearly wipes out the differences between the skilful, the average, and the weak worker, with the result that the level of piece-work prices is lowered more and more to the capacity of the last one. The author has known cases where this phenomenon has lowered the output of the works 20% and more, under the possible output, thus endangering the very economy of the whole concern.

This brief explanation may be sufficient to show that the problem of fair piece-work wages, even when it can be solved satisfactorily, is by no means an easy one : it needs a firm but just mind, trained technically, economically, and psychologically ; it needs patience to introduce it in replacement perhaps of an out-dated system ; and constant attention where it is already in use ; for with changing working conditions—and they will never be constant in a really up-to-date works—prices must change correspondingly.

Finally, it should not be forgotten that this piece-work wage system should be connected with a guarantee of a minimum wage, usually the hourly rate, fixed by agreement—*i.e.*, perhaps 75% to 80% of the hourly earning in piece-work—a fair protection for the men against circumstances which may arise through no fault of theirs. When a man is not capable of increasing his earnings above this minimum level, say, during two or three wage periods, he should be removed to another more suitable workplace; but another man who can and does earn more than the expected average—the excess may be as big as possible—must not be disturbed under any circumstances.

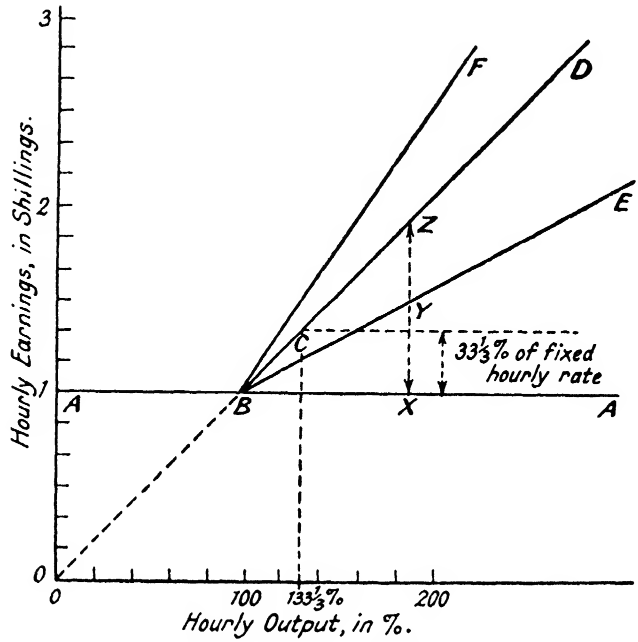
**3. Other Wage Systems.** The difficulties of building up, introducing, and maintaining a fair piece-work system, and also the wish to have in the wage system some incentive, as is undoubtedly contained in piece-work prices, have led to many other systems, known as payment by result, premium, bonus, incentive, etc., and much has been written about their relative merits. The author had many opportunities of studying these systems, both theoretically and in practice, but as a definite solution could not recommend any of them ; only in rare cases did he use them as a temporary or additional measure.

They are too complicated when calculating the earnings of the men ; they are too difficult to be easily understood by the men, and therefore the suspicion of the men is likely to arise ; they render more difficult the estimating of costs ; and they are unfair either to the men or to the works. In nearly all cases they consist in the distribution of earnings, in excess of the level which had been expected, between the men and the firm, whereas in the piece-work system this excess is given entirely to the worker whose higher efforts have produced it. The works receive their share by the increased output and the correspondingly lowered overhead costs, and are not entitled to obtain a second part at the cost of the men. Where, however, such a wage system is built up with the idea of increasing the excess of earning above the average, which is not proportional to the increase of output as with the piece-work system, but a rapidly increasing proportion, either the worker is over-exerted, the plant is worked too hard, or, mostly, both occur and a breakdown is invariably the result.

These are the reasons why, in principle, the author is against all these systems ; he has known many cases where they have been introduced with great enthusiasm and hopes, but had to be abandoned after a long or short trial, leaving both the management and men disappointed, and a situation giving more trouble than that experienced if the original scheme would have been maintained. It would not be surprising if some readers could give examples of an opposite nature, but special circumstances may have been the reason, as, for instance, a change from an incorrectly built up and badly applied piece-work system, when it was intended to avoid some of the former mistakes.

Under these circumstances, the author does not intend to consider these premium systems in greater detail, but the

accompanying illustration, Fig. 15, shows the principles of the various systems which it is hoped will be understood without further explanation.




(Output with average performance taken as 133⅓% according to agreement)

Line A–A represents the fixed hourly rate system.

Line A-B-C-D represents the piece-rate system with a minimum wage = fixed hourly rate.

Line A-B-E represents a premium system, the men and the works sharing the excess of earning—for example, X–Y = share of the men ; Y–Z = share of the works.

Line A-B-F represents a premium system with an excess of earning increasing quicker than the output.

Fig. 15. Showing the principles of various wage systems.

## B. APPLICATION OF WAGE SYSTEMS IN IRON AND STEEL WORKS

**1. Tonnage as Measure.** One kind of " payment by results " is noteworthy, and to which the readers' attention may be directed because this system is so often found in metallurgical works, despite the fact that a short consideration shows it does not satisfy the simplest demands which must be made to a system pretending to be a payment by result—*i.e.*, the tonnage bonus.

If the expression, "payment by result," is a logical one, it can only mean that somebody, in this case the workman, is paid according to the result obtained by his work; and the piece-work system, as explained above, is a real payment by result. But the produced ton is only a correct measure of the work done in rare cases—*i.e.*, if real mass production without change of quality, dimension, production method, etc., takes place. In all other cases a ton of one class is not equal to a ton of another and therefore the ton cannot be a fair measure of the work of the men. Moreover, the workers have not the slightest influence as to which class of product has to be produced; perhaps in one week the products to be delivered involve increased work and increased time in consequence; the earnings in this week will be lower. Of course, in another week the reverse may occur and the earnings exceed the average, and in the long run it will be equalised; but there are these fluctuations which irritate the workman with his small budget, and create, perhaps unconsciously, an ill-feeling, because he knows that he has done his job properly week after week in the same manner.

Of course everyone knows and appreciates these facts; but how often are they overlooked in daily practice? The mill manager asks the foreman why the mill has produced only 420 tons this week, against an average of 500 tons during last year. The workmen ponder on Friday morning that *more* than one and a half days' work are necessary during the running week to reach "their earnings." The salesman and the controlling cost accountant grumble that again the mill has not done its duty during the past week, because it has not done its average tonnage, etc.

That of course is all wrong, and everybody agrees that it is; but the habit has grown to such an extent that it can rightly be spoken of as an illness of the mind, a "ton-psychosis," and it seems to be opportune, under present working conditions involving stronger competition and more strained labour relations with the greater necessity for control of economy, to dispense with this thoughtless method of expression. The author does not exaggerate by stating that much greater success will result from a saner method of measuring, or at least the adoption of the best possible one. It would clear the whole atmosphere in the works and remove the reasons of much misunderstanding and heated discussions between the persons concerned, and the methods of

planning and progressing, of costing and controlling, would be simpler and cheaper.

What are the methods of measurement which could be used instead of the actual weight expressed in tons? There is, first of all, the *working time*, secondly, an "*equivalent ton*," a term which will be explained later, and thirdly, a combination of both.

**2. Working Time as Measure.** We need only study the interesting report of the Rolling Mill Committee of the Iron and Steel Industrial Research Council, as published by the Iron and Steel Institute,[1] from which we will see how great the difference is when using time instead of tonnage as measure. The table in Fig. 16 of cogging times of three different types of ingots is taken at random from pp. 44, 45 and 46 of this report.

| Type of ingot | Size of blooms in in. | Weight of ingots, Tons. | Cwt. | Rolling times, Secs. or Mins. |
|---|---|---|---|---|
| W.P. | $7\frac{3}{4} \times 7\frac{3}{4}$ | 2 | 7 | $174 = 2{\cdot}9$ |
| $S_1$ | $10 \times 4\frac{1}{2}$ | 3 | 2 | $276 = 4{\cdot}6$ |
| X | $10 \times 4\frac{1}{2}$ | 2 | 5 | $210 = 3{\cdot}5$ |
| $S_1$ | $6 \times 5$ | 3 | 2 | $318 = 5{\cdot}3$ |
| X | $6 \times 5$ | 2 | 5 | $252 = 4{\cdot}2$ |
| $S_1$ | $3\frac{1}{2} \times 3\frac{1}{2}$ | 3 | 2 | $540 = 9{\cdot}0$ |

FIG. 16. Cogging times of three different types of ingots.

A cogging performance card from p. 50 of the report is shown in Fig. 17. It indicates how these figures are used for building up a report from which the efficiency of the shift can be seen. Of course, this report could also be made out using tonnage figures instead of time, and considering it separated from reports of other shifts, no advantage seems to be evident by the one method against the other. Assuming, however, that the mill had to roll, instead of the mixed programme as indicated by Fig. 16, 105 ingots, type W.P., $7\frac{3}{4}$ in. $\times$ $7\frac{3}{4}$ in., on the one hand, and 34 ingots, type $S_1$, $3\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in., on the other hand, the total standard cogging times would be nearly the same in all three cases as $105 \times 2{\cdot}9 = 34 \times 9{\cdot}0$ approximately 305 minutes. Obviously, the performances of the three shifts would be equal too, but the outputs would differ very much :—

| | | Tons |
|---|---|---|
| 1. | 105 ingots, W.P. $7\frac{3}{4}$ in. $\times$ $7\frac{3}{4}$ in., each 2·35 tons | = 247 |
| 2. | Performance according to Fig. 17 | = 195·9 |
| 3. | 34 ingots, $S_1$ $3\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in., each 3·1 tons | = 106 |

[1] See extract below, pp. 130 to 134.

| Date | Shift | Foreman | Tonnage Rolled | Yield | Overall Performance | Cogging Performance |
|---|---|---|---|---|---|---|
| Nov. 5th, 1936 .. | 6/2 | B | 195–9 | 22·0 | 67·1% | 90·2% |

| No. and type of ingot cogged | Size of blooms made (ins.) | Areas of blooms made (sq. in.) | Standard times per ingot (mins.) | Total standard cogging times (mins.) |
|---|---|---|---|---|
| 6 W.P. | 7½ × 7½ | 60 | 2·9 | 18 |
| 37 Sl | 10 × 4½ | 49 | 4·6 | 170 |
| 6 X | 10 × 4½ | 49 | 3·5 | 21 |
| 15 $S_1$ | 6 × 5 | 30 | 5·3 | 80 |
| 1 X | 6 × 5 | 30 | 4·2 | 4 |
| 1 $S_1$ | 3½ × 3½ | 12 | 9·0 | 9 |

| Booked delays | Mins. | % of working time |
|---|---|---|
| Heat .. .. .. .. .. .. | | |
| Mechanical and electrical .. .. .. | 50 | 11·1 |
| Waiting Mill .. .. .. .. .. | 55 | 12·3 |
| Charging cold bloom .. .. .. .. | | |
| Steam .. .. .. .. .. .. | | |
| Re-cogging blooms .. .. .. .. | 10 | 2·2 |
| Other causes .. .. .. .. .. | | |
| Total delays .. .. | 115 | 25·6 |

| | |
|---|---|
| Weight cogged .. .. | 195·9 |
| Blooms made .. .. | 175·12 |
| Billets made .. .. .. | 2·7 |
| Blooms re-rolled .. .. | — |
| Tons per hour (over shift) .. | 26·1 |
| Tons per hour (ex delays) .. | 35·0 |
| Yield (cwts. per ton) .. | 22·0 |

| Ingots Charged | |
|---|---|
| Hot .. .. | — |
| Black hot .. | — |
| Cold .. .. | 60 |
| Preheated .. | 6 |
| | — |
| Total .. .. | 66 |

| Summary | | |
|---|---|---|
| Working time (shift time—meal time) .. | 450 | 100 |
| Actual cogging time (working time—delays) | 335 | 74·4 |
| Standard cogging time .. .. .. | 302 | 67·1 |
| Lost time (actual—standard) .. .. | 33 | 7·3 |
| **Performance** | | |
| During cogging (standard/actual) .. .. | 90·2 | |
| Overall (standard/working) .. .. .. | 67·1 | |

Remarks

Fig. 17. Cogging performance card.

It will be agreed that these output figures are greatly misleading in judging the mill work, and even if it must be admitted that we have selected extreme cases and that the differences will not usually be so great in practice, these cases are by no means impossible.

What would be the result if these output figures were made the basis of future consideration ? In planning beforehand the possible output of the mill according to average figures, perhaps represented by the performance card (Fig. 17), it will be noted that case 1 would take over ten instead of eight working hours, and case 3 only four and half hours. If these three shifts were worked one after another during one day in the morning, afternoon, and night, and a tonnage bonus was paid separately to each shift, the morning shift would earn 26% more, and the night shift 45% less than the average represented by the afternoon shift. And yet the performance of all three shifts is nearly equal, showing that the men have worked with the same efficiency in each. But wrong results would also be shown in calculating the costs per ton if based on the output figures alone.

Of course, this difficulty is quite well known in many works, and methods are used to overcome it, either by pooling the earnings of the three shifts, or by paying an hourly fixed rate to the men, and in addition a correspondingly smaller bonus per ton, thus making the unfair manner of payment less obvious.

But why make this procedure so complicated if a simple way, clear to all concerned, is so obvious—*i.e.*, using the rolling times, determined by proper time studies or any statistical method, as basic figures for planning, payment of wages and costing purposes? The men, especially, will soon recognise the fairness of this method, and be grateful for preventing fluctuations of their earnings associated with the old method, fluctuations not due to their working efficiency, but mostly caused by circumstances outside their influence, especially, for instance, the composition of the mill programme.

The author would not like to conclude this example, however, without raising the question : Is this kind of work, the team work at one of the big rolling mills, really that sort of work which one has to consider as a proper job for any method of payment by result ? It should be considered that the mill itself is, to a great

extent, the governing factor of the output, that, as already mentioned, the composition of the mill programme has a great influence, that the nature of the work calls for a strong supervision, and therefore, as far as possible, for the avoidance of delays. Is this not one of the cases, mentioned before, where a return to a fairly fixed hourly rate would be the right way, removing many reasons for unpleasant discussions with the men, and—what is often forgotten—much clerical work ?

There may be reasons for keeping to the present custom ; but, if that is the case, the step from the unfortunate tonnage bonus to a fair piece-work rate based on time should be taken under all circumstances.

The example of the rolling mill is used, because it is one where the advantages of the above principles can easily be explained, but it may be pointed out that similar considerations also apply to furnaces of any kind, to many apparatus in chemical factories, to some machine tools, etc.

**3. The "Equivalent Ton" as Measure.** Sometimes it seems to be useful to keep to the habitual expression of tonnage as a measure of output, etc. Then it is necessary to modify at least the pure weight-ton in such a manner that the different kinds of tons produced—*i.e.*, the tons of different value, can be added up without obvious mistake. One special kind of produced tonnage is taken as a basic figure, perhaps that kind, whose output used to be the greatest. The special properties of this kind of tonnage are carefully investigated in so far as they determine the value of a ton, the same is done with all other kinds of tons produced, and the figures of the individual properties are put into relation to each other, thus building up some factors, which allow the reduction of the value of each kind of ton to that of the basic ton, which is called "standard ton" or "equivalent ton."

The author would prefer the second term, as the word "standard" has obtained a special meaning in its association with the work of the British Standard Institution, a meaning which indicates the importance of the standard product for a whole branch of industry, whereas we have to deal in this case with something important only for the individual works in question.

This working with equivalent figures is mainly used for costing purposes, but there is no question that it is also useful when

projecting a new layout for a workshop or changing the old one, when planning the possible output, etc.

How this method is used may be shown by two examples taken from actual practice. The first refers to a constructional department of a big iron and steel concern. The production programme of this department was very variable ; it changed between light constructions—*e.g.*, light-posts where the wages formed a comparatively high percentage of the total costs, and very heavy constructions, as, for example, big river bridges. Careful statistics over rather a long period showed that it would be useful and sufficient to divide the total products into six classes, according to the different influence of the wages to the total costs per ton. Taking the share of the wages in the Class I, with the lowest share equal to 100, those of the other five classes could be fixed with sufficient accuracy to always one-fifth more of the total difference between Class I and Class VI—*i.e.*, to 116·6, 133·3, 150·0, 166·6, and 183·3. If, therefore, in an individual month the actual output in tons for each class was known, and Class I had been selected as basis—*i.e.*, formed by "equivalent tons,"—the total output in equivalent tons could be determined easily as follows :—

| | Actual output in tons | Equivalent figure | Equivalent output |
|---|---|---|---|
| Class I | 110·4 | 100 | 110·4 |
| Class II | 279·3 | 116·6 | 325·7 |
| Class III | 336·4 | 133·3 | 448·4 |
| Class IV | 356·7 | 150·0 | 535·0 |
| Class V | 218·1 | 166·6 | 363·4 |
| Class VI | 178·6 | 183·3 | 327·4 |
| Total | 1,479·5 | — | 2,110·3 |

Fig. 18 shows the result of this method of consideration during a period of twenty-one months, and the advantages of the method may easily be recognised. Whereas Curve 1, the material actually despatched, shows fluctuations which are partly inexplicable, the trend of Curve 2, representing the output in equivalent tons, is more steady ; but that this second curve is really a better representation of the actual work of the shops can clearly be seen in comparing Curve 3 and Curve 4, showing the working time per despatched and equivalent ton. It is regrettable that reproduction on a necessarily small scale cannot give clearly enough the

fluctuations of Curve 4 ; as a matter of fact in the original they indicate the improvement of the economy of the works at the end of this investigation, due partly to the higher output and partly to improvements in the shops based on observations during this investigation ; this was carried out with the purpose of decreasing the transport costs and was very successful.

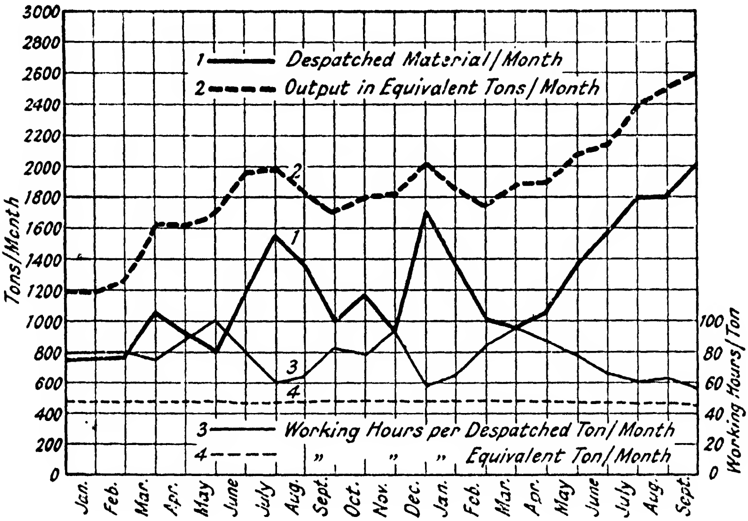



FIG. 18. Output of the shop.

The second example of the use of equivalent figures is taken from an investigation in a factory of iron barrels also connected with a big iron and steel works. In this case the problem was more complicated in so far as the more superficial treatment of classification as used in the first example would not have brought sufficiently accurate figures of comparison. On the other hand, it was fortunate that when starting the investigation equivalent figures had already been in use four years, and therefore sufficient figures of comparison were at hand to build up diagram Fig. 19, from which all necessary basic figures can be taken. As may be seen, seven different constructions of barrels were produced, and for each construction barrels of various volumes.

For comparison purposes again, the value of the necessary labour was taken, expressed in working minutes as determined by time studies for fixing fair piece-work prices ; but not an

actually produced barrel was used as a basis. In this case an "ideal barrel" was selected, using sixty working minutes, as in this way the basis will be constant, even if the working conditions of the "equivalent barrel" change and therefore the possibility of comparison over longer periods will be maintained. This equivalent could be used for the determination of a manning plan

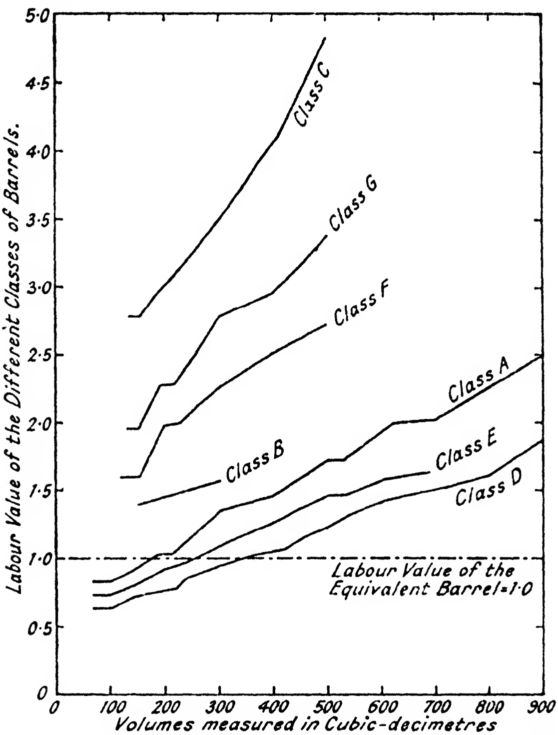



FIG. 19. Labour values of different classes of barrels plotted against volumes.

separately in eight different shops occupied with barrel production, for fixing correct dates of delivery, for daily control of output and production, and for building up production costs.

Finally, it may be mentioned that a third example for using working time as a measure and a basis of fair piece-work prices on the one hand, for applying equivalent figures for costing purposes on the other hand, taken from a wire rod mill plant, is published in detail in "The New Management," pp. 166 to 218.

All three investigations were carried out in large iron and steel works and published under the personal responsibility of the author.

**4. Piece-work Wages at the Finishing Bank.** It is usual in metallurgical works that the "hot" part of production, the melting shop, the hot rolling mill, etc., is succeeded by a "cold" part, mostly called a finishing bank. (These workshop terms may not always be correct; for in some cases, as, for example, in special steel works, hot processes, such as annealing, normalising, etc., are included in the work of the finishing bank.) Generally speaking, it is the job of the finishing bank to remove, as far as possible, certain defects of the material coming from the hot departments by annealing, chipping, pickling, straightening, etc., to put additional work into the material, according to the customer's orders, by sawing, shearing, or breaking to certain lengths, by milling or slotting, punching holes, etc., and to prepare the material for dispatch by carting, packing, bundling, etc. Here is the proper field of the piece-work wage system, but it is only too often here that old-fashioned methods of rate fixing are found, where the tonnage bonus system particularly exercises its fatal influence, since it is only in rare cases that the *weight* is one of the governing factors of the work, as, for example, with annealing. Usually the lengths, the cross-section, the quality of the material, the number of pieces ordered, etc., are much more important. Of course it is a much more difficult job, taking time and meditation, to consider all these various circumstances, but it is a job worth while doing, not only because it leads to fair piece-work prices—which the old method will never do—but because it clears the actual working conditions at the finishing bank to an extent unequalled before, thus inducing improvements of layout, procedure, and organisation.

It is not possible here to give an extensive guide as to how this job should be done, especially as the circumstances vary very much from works to works, but some hints and an example may help.

As a rule, it is necessary to differentiate between setting time, main time, and lost time when calculating the total working time, and to consider each of these times separately in order to find the governing factors. Thus, for example, Fig. 20 shows the time in minutes per piece for straightening a certain section by a

roller-straightening machine, plotted against the length of the piece. This time is $T = t_s + r \times L$, $t_s$ = setting time per piece, L = length of the piece, and $r$ = the incline of the straight line which has been found by time studies for various lengths, the figures at the points showing the number of investigations on which these points for the various lengths are based. For Z pieces with a total length of $y$ feet, the total working time will be time per foot $\times y$ + time per piece $\times$ Z. The incline will be

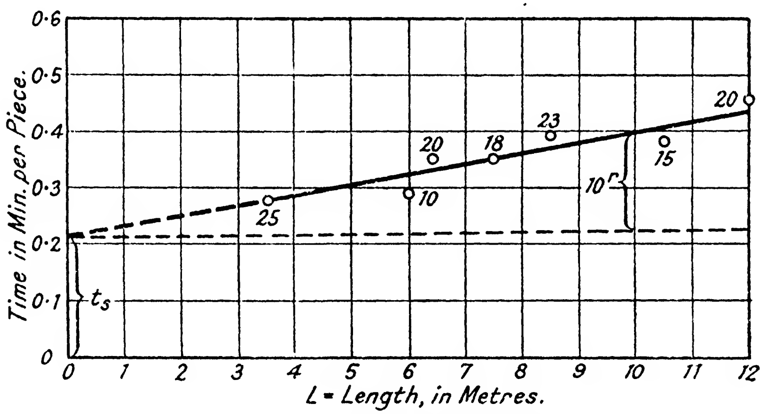



FIG. 20. Time T for the straightening of section X on a roller-straightening machine : $T = L \times r + t_s$ min./piece.

nearly the same for similar sections—*i.e.*, parallel lines will result, but will differ for different sections. It is suggested that unavoidable lost time is included in the basic figures for $t_s$ and $r$.

Often, however, it is necessary to repeat the straightening as performed at the roller-straightening machine, under a separate press, because the former does not work accurately enough, in which case a similar calculation must be made for this second straightening. As the costs for this press work are much higher, it is advantageous to give an incentive to the men to increase the accurateness of the roller straightening as far as they can. This can be done by determining how much of the roller-straightened material, measured in per cent. of the total, usually has to be straightened afterwards under the press, and to pay an increased rate for each per cent. saved in the actual press straightening. Both parts, the men as well as the works, will thus share in the profit.

Even when the fair piece-work prices are determined there are some difficulties of organisation which must be overcome if they are to be applied according to the actual working conditions. Of these only two may be mentioned.

The first is to separate the material according to the orders to which they belong. The billets, rounds, slabs, plates, etc., may have different dimensions; then a division is easy; they may have different qualities; then a division can and must be made, corresponding inscriptions either by painting or stamping, and if multiples of lengths are cut into pieces care must be taken that these inscriptions are repeated on each single piece. It may be that exactly the same products of similar dimensions and quality are required for different orders, and those inscriptions have to be added according to the orders. Experience has shown this to be possible throughout, but the workers often falsely regard it as "red tape," designed to reduce the actual work for which they are paid, and it needs strong supervision and the conviction of the men that this marking is part of their work, and the time necessary is calculated in the piece-work price. It is doubtful whether this work of marking should be given to a special marking gang as then mistakes may creep in more easily; in such a case the division of labour seems to be exaggerated.

The second difficulty arises if one is forced to insert work against a fixed hourly rate between piece-work from time to time. This cannot always be avoided, whether it is the work of rolling mills or machine tools on the finishing bank. It is only natural that there is a tendency to increase the time of day-work on the records against that which is actually worked, although that is strictly speaking a fraudulent measure. The organisation should take care to avoid this by always handing out to the men only one order at a time. That, of course, is easier said than done, but no other known method ensures a real coincidence between work and records and checks the fairness of piece-work rates simultaneously.

## C. SUMMARY

To develop a wage system in an industrial works as fair as possible in present economical conditions is of such importance for the co-operation of employees and employers that it may be justifiable to summarise in the following conclusions the main

contents of the previous discussion. Thereby it may be emphasised that they are the result of the author's personal experience, but that they cannot be considered as a common standard, but rather as a compromise developed in view of the many difficulties connected with this delicate problem in practice.

(1) The system of labour payment and the building up of weekly wages should be as simple as possible so that even the least educated workman is able to understand how the sum in his wage packet is made up.

> Many existing agreements between employers and employees may have been very clear and simple when first put on paper, but changes and additions have been made in the course of time which often make the understanding and the application of these documents very difficult. Cases are known where in big factories even the specialists in the wages office did not completely agree about the meaning of this or that sentence. Where that is the case a new working through the agreement and rewriting in plain language is recommended. This opportunity should be used to form all instructions so as to keep the clerical work in the wage office as simple as possible.

(2) Only the two wage systems of fixed rates and of piece-work rates can be proposed generally, a premium or bonus being allowed perhaps in addition to one of the first two systems as remuneration for avoiding rejects, saving material, etc.

> The payment of human labour by the (hourly, weekly, monthly) fixed rate as at present used *only* where payment by results is either impossible or cannot be recommended owing to the nature of the work, can be considered as ideal. It should be the endeavour of all concerned to increase the sphere of fixed hourly rates by the technical development of the plants as much as possible ; piece-work wages should be considered only as a substitute made necessary by imperfections of human nature to be used where an incentive is unavoidable because the plant itself is either not yet fully automatic or is not yet built up in such a manner that the speed of the work is almost independent of the human element, as is the case with work in an up-to-date power station and work on a continuous belt.

Premium and bonus systems should not be used as fundamental wage systems as they must be considered as attempts at withholding from the workman a part of the wages he should obtain as a result of his doing better work than expected on an average.

(3) The fixing of rates per hour either for direct payment of wages according to the fixed hourly rate system, or as basis for the calculation of piece-work prices should in principle be part of the agreement between employers' federations and trade unions, the heated discussions of this matter thus being kept away from the workshop once and for all.

Where, owing to the peculiarities of the work in the works concerned, an elaboration of these rates in greater detail is necessary that could not be expediently included in the general agreement, special arrangements should be made between the two parties based on the figures of the general agreement as minimum rates.

(4) When using the piece-work system an hourly rate should be fixed as minimum payment in case the man would not earn with or without his fault even this fixed rate, which is best settled in the general agreement as a certain percentage of the average earnings for the same work when working in fixed hourly rate.

It is due to the nature of the piece-work system that the earnings of the men are subjected to some fluctuations, but the workman not being usually in a position to collect sufficient reserves must be protected against breakdown on account of bad luck or mistake by the guarantee of a minimum income. On the other hand, the employer must have the right to change the work place of a man or even to dismiss a man who is working in piece-work and, owing to his own fault, does not earn the minimum rate for some periods following each other.

(5) Piece-work prices once fixed and agreed upon should not be changed without express consent of the men as long as the methods of production have been practically unchanged.

The unfair "cutting of prices" must be avoided in all circumstances. It cannot be considered as anything else but

a breach of promise ; and the bad results of this method as the main obstacle to a real spirit of co-operation are well known. On the other hand : If the workmen are thus protected against any other upper limit of their earnings but their own ability and industry, a complete cessation should be expected of that holding back of labour which can unfortunately be observed so often in industrial works and which is incompatible with the true spirit of co-operation.

(6) Fixing of piece-work prices is not a bargain between foreman and workman, but the careful determining of the time the job in question needs in the given conditions of work when applying average skill and eagerness. All methods known at present as suitable for the determination of these times, especially *work and time studies*, should be allowed and applied in the shops and should find the eager support of the workmen.

It is true that these methods have been used in some cases in a manner detrimental to the workers : but is there any method which could not and has not been abused and does that speak against the method itself ? There are at least as many if not more examples of the contrary effect, and the workmen have so many means of enforcing a fair application that by now the antagonism of the workers against these modern methods of determination of fair piece-work prices begins to be ludicrous.

There are already many workmen who recognise that flatly and it is time that the trade unions follow and convert their fight against time studies into an assistance for introducing and applying them in a correct manner.

## D. THE CONTROL OF WAGES

**1. General Considerations.** When dealing with the problem of wage-booking it is not intended to describe one or several of those many " systems " which are perhaps developed with great care for a special case, and often advocated by their originators as the universal remedy for any works in any kind of industry. We are here concerned only with the principles according to which the problem of wage-booking should be solved ; and where examples are given, they have to be taken as such—*i.e.*, illustrating an idea, not as instructions that would be applicable in all cases.

Before going into details, the need for economy of effort may be emphasised. The wage office is dealing with ready cash, and it is obvious that its work must be carried out with utmost care and accuracy. This certainly correct point of view, however, seems to tend only too easily to "over-organisation," in so far as one and the same process or fact is booked in two different ways. That, of course, results in a double checking, but represents unnecessary work, for one method could have been used and with reasonable care would prevent mistakes. It should not be forgotten that the principle of economy governs the problem of wage-booking too. It is therefore necessary, before organising the work of wage-booking, to review the situation, and to eliminate all statements and statistics which are not necessary. Admittedly, problems may arise in special cases which need a more than usually detailed study of the vouchers coming from the shops, and these must be filed in a manner easy for reference after use for the main purposes of wage-booking. Care must be taken that such special studies do not lead to a new series of statistics which may not be used afterwards; for this is one of the directions in which "over organisation" starts.

The booking of wages can be divided into two parts: the booking of wages in the shops, and the treatment of the various vouchers coming from the shops into the wage office. It is surprising to see that generally, in practice as well as in literature, the second part is dealt with more carefully than the first one. And yet it cannot be denied that the former is the basis of the latter, and that no subsequent accuracy can correct any mistake made in the earlier stage. It should therefore be the duty of any organiser to give the utmost attention to this first booking in the shops. Why that is so often overlooked will always be a puzzle; perhaps the reason is that the greater difficulties arise here and that human nature tends to take the line of least resistance. We will not make this mistake, and will attempt to find out which demands have to be fulfilled by this initial booking in the shops.

Because a truth should be obvious, it is still worth mentioning; and yet it must be emphasised that it is just these apparently small and self-evident matters which, if neglected, cause great trouble later on.

(1) No work whatever should be carried out by any workman for which a written order is not at hand or, in emergency cases,

made out during or immediately after the work. There are many cases in practice where this demand looks like "red tape," and workmen as well as foremen are only too easily inclined to look at it from this point of view. That does not matter. This condition must be maintained rigidly, or one may lose all necessary survey of what is actually going on in the works, and control will be incomplete. A second question is: who shall make out this written order, and how he shall do it? Various ways are possible, and it will depend entirely on the special organisation of the works as to which shall be used. We are not concerned here with any special "system," but with basic requirements, and will therefore give no answer, but must mention that the very person who is often entrusted with this work is the wrong one—*i.e.*, the foreman. He is the supervisor of the work and of the workmen in the shop, and not a clerk; and any clerical work which he has to do keeps him in his cabin and away from his proper job. This rule should be put aside only in emergency cases.

(2) Carefully prepared printed forms should be provided for these orders and for the vouchers of the work done—often the same form can be used for both purposes—not only in order to diminish the writing work, but especially to guarantee that no important note be forgotten which may be necessary for later identification of the work. What, then, remains to be written into these forms should not be done by the workmen themselves, as is so often the case. The reason for this rule is not distrust of the honesty of the men, but the fact that they are not clerks, but workers; they are not accustomed to this job, and those who are best on the machines and at the bench are often poor writers, and their time is too expensive. It pays very often to have a special clerk doing this work better, and in shorter time.

(3) In organising this kind of work, care must be taken first of all of the demands of production control—*i.e.*, it must be easy for the foreman or the departmental manager to obtain from these papers a survey of the work of an individual, or a group of men, during a certain period, or for any special job. These papers must be filed for possible reference later, in case of any complaint, or for statistical purposes. Only after these demands are fulfilled can the wishes of the wages office, of the costing department, etc., be taken into consideration.

**2. The First Booking of Wages.** As already mentioned, many and ingenious "systems" are developed and described in literature how these vouchers for wages should be carried out and used in the shops, etc. Almost each type has its advantages and disadvantages, and the best organisation is that which is sufficiently flexible to be able to use in each shop that form which is most suitable for its particular kind of working. Ardent advocates of the modern trend of booking each fact on a separate slip of paper or card may be astonished to hear that the author is, in this sense, defending for some cases the "good old" diary of the individual workman, of course not kept by him, but by the above-mentioned clerk. It gives, for example, in repair shops a survey of the work of a fitter sometimes working on this, sometimes on that plant, as no slip-system can offer without special work. That may be of such advantage to the supervising engineer that the disadvantages of the diary-system could be disregarded.

Fig. 21 gives an example of a wage ticket which has been used in this form in a factory for various products for hourly fixed rate as well as piece-work wages. It may illustrate the various circumstances which must be considered in order to give all necessary details if, for example, the form would be used at a finishing bank of a rolling mill or in a machine shop of a big metallurgical works. There an individual work-piece has to undergo various operations one after another, and for each of these operations a special wage ticket is necessary, differing from the previous only in certain details. These wage tickets can be clipped together in the form of a booklet and accompany the material from one operation to the other, that ticket being torn out of the booklet which represents the operation just carried out. In this case the wage tickets identify to a certain extent the material already distinguished by stamping or painting, as explained before.

It may be emphasised that in each case for work at a fixed hourly rate as well as for piece-work, the time actually taken should be entered on the wage ticket. That is necessary for costing purposes in case of work at hourly rate, and also for checking the piece-work prices on piece-work. The reverse of the wage ticket, as shown in Fig. 21, is used for this purpose, the carrying out of which is not so easy as may appear at first glance.

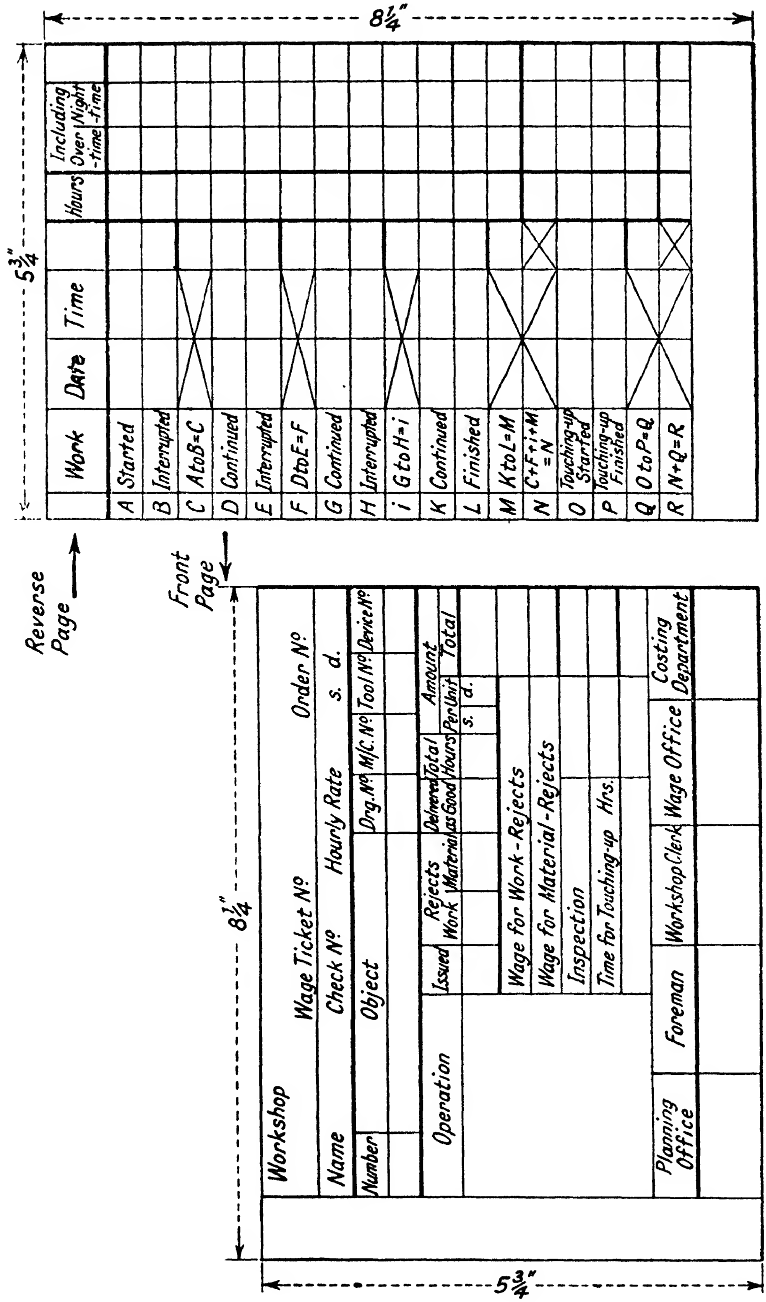



FIG. 21. Wage ticket.

There is certainly a tendency for the men to obstruct this measure, and even the management sometimes declares it to be superfluous. The objection of the men may result from the mistrust that this checking of piece-work prices is done with the intention of price-cutting. That can and must be overcome by a frank and honest wage policy, and the very discussion of this question of entering the actual working time into the wage tickets may provide an opportunity to the manager of the shop to make a clear explanation of his standpoint and afterwards to show that he stands by his word. The objection of the management mostly results from the consideration that the piece-work prices, if once fixed, should not be changed, and that it therefore does not matter how long a time the men use for a special job. That means a misunderstanding of facts ; a change in the piece-work price is necessary if a mistake has been made in fixing it, and if the working conditions have changed considerably. Both can be found out only by continuous checking as the " rate-fixer " will not always be informed by the people responsible for production when a change or improvement of production methods has taken place. Thus " good " and " bad " piece-work prices will occur, even if the original ones have been correct, and the bad consequences connected with them will result. Now this entering of the correct working time is by no means an easy job. As already mentioned, there is no other way to come to it than by limiting the work which a man has in hand simultaneously to a single job, indicated by the one wage ticket which is given to him. He has to return it when the job is finished, or must be interrupted, and should begin a new job only after receiving the wage ticket belonging to it. Suitable arrangement of the layout of the shop as well as of the organisation is necessary, to avoid too far and too frequent walks of the men to the place—generally the foreman's cabin—where the tickets are issued. It is often said that what has been described above is an exaggeration, and this " system " could never work in practice satisfactorily. Experience has shown on various occasions that that is wrong, and that a clear survey of the work actually done in the shop is more than worth the organising and clerical work entailed. Of course, the difficulties of introduction are not small, but when it is running it is simple in operation, and the very workmen who may have opposed so strongly at the beginning are then the most eager advocates.

**3. Wages Summaries Per Worker and Week.** The total working time of the men, formerly controlled by the watchman at the entrance of the works, is at present mostly checked by the "stamp clocks," the construction and use of which can be taken as generally known. Often an attempt is made to combine the workman's diary or the wage tickets in some way with the stamp cards used in these clocks, and the idea is attractive at first glance. Practice has shown that this can be recommended only in rare cases. The author has seen more works where the printing on the back of these cards for this purpose has not been used than those where it has actually taken place in the intended manner. Of course, in the case of piece-work a comparison of the total working time as given by the stamp cards of a man, and as given by the number of wage tickets finished by him in the same period, must be made, but that should be done on a separate form, with sufficient space to show in detail how the gross earnings during the week are made up by the wages for the various jobs, which additions for overtime, etc., have been added and which deductions for insurance, etc., have been made, thus obtaining a net sum, which will be paid in cash. When these summaries are made by the wages office so that they can be distributed to the men, say, on Thursday for the preceding full week, the men have time to check them and make any claims for adjustment before the money is actually paid on Friday. Thus one can avoid differences not being cleared in time and money paid the next week which should have been paid in the previous week. The ratio of such claims or adjustments to the total number of workmen is a very good criterion of the organisation of the wages office. The author remembers quite well a factory occupying 1,200 to 1,300 men in a very complicated production where the average number of such adjustments per week, taken over a whole year, certainly did not exceed two or three.

**4. The Purposes of the Work of the Wages Office.** It is the duty of the wages office to collect all wage tickets, stamp-clock cards, and other vouchers used in the shops for recording working times and wages, and to draw the necessary conclusions from the figures and dates they contain. But it also plays an important *rôle* in the relations between the men and the management; for the confidence of the men is based to a great extent on the correct and fair payment of their earnings ; thus it is only natural that

this work of the wages office is generally carried out with utmost care and accuracy. And yet it is often found that the proper organisation of this office is built up in a rather haphazard manner. That can best be avoided or improved upon by a clear analysis of the functions of this office.

They are manifold : First of all, it is its duty to find out for each workman whose name is on the wages list the true earnings during the last finished wage period (mostly a week); it has to put together these individual earnings in the pay roll, so that the necessary ready money can be asked for, paid into the individual wage boxes or packets, distributed to the various shops and handed over to the men at the right time (usually Friday of the following week).

Secondly, it has to provide the works manager, his departmental managers and foremen, with all statistical data necessary for judging the correctness of the rates, hourly-fixed as well as piece-work, in relation to the work done ; and the earnings of the individual worker as well as certain groups of workers per hour, per week, and per year ; average figures of these items for comparison purposes ; further numbers of the workers divided according to age, sex, trade, actually working, and absent because of illness or leave ; labour turnover, with necessary details ; finally, the number of working hours, divided into normal hours and overtime, net working time, meal times and stoppages, etc. From these data all conclusions must be drawn and issued in handy form, in so far as the works management asks for it, but no more ; for statistics which are not used represent unproductive work. Careful consideration is therefore necessary to make the right selection.

Thirdly, the wages office has to provide the costing department with similar information as it does to the works' management, the details of which are determined by the system of accountancy adopted in the works, and therefore variable from works to works.

Of course, it is not only possible, but even probable and desirable, that figures prepared for one of these three groups of purposes can be used for one or both of the others.

**5. Some Features of the Organisation of the Wages Office.** If we consider the work of the wages office from these three aspects we find that it consists of—

$$\left.\begin{array}{l}\text{(1) Collection of wage figures}\\ \text{(2) Separation of wage figures}\end{array}\right\}\text{ from different points of view.}$$

(1) The collecting of wage figures takes place first of all in the pay-roll, which, as the name indicates, is the basis of actual payment of the men in ready cash. Therefore it contains against the name of each worker all details, how his gross earnings are transformed into net earnings and the payable sum by means of the various deductions or stoppages for insurances, money advanced, etc., and the sub-division of money in paper and coin, for distribution into the individual pay-packets.

The pay-roll should also give, however, such other details as profession, working hours, either against piece-work rate or fixed hourly rate, overtime, etc.; for these are necessary for many statistics which are best based on the pay-roll.

(2) The separating of wage figures is less commonly used. It is based on individual accounts for each worker, again containing about the same figures as the pay-roll, but so arranged that a survey of the weekly, quarterly, and yearly earnings of the worker are obtainable without special investigation of the pay-roll. These accounts are sometimes connected with a muster-roll of the workers, giving all necessary personal details about each man—his age, address, date of engagement in his present occupation, wage rate, promotions, etc. These accounts have proved useful in many cases, especially in big factories, as a basis for negotiations with the men themselves, the works' council or trade unions, in answering questions of the Inspector of Income Taxes, etc., also for some statistics which may be required. Still, it cannot be denied that these accounts, mostly made out in the form of card indices, cause considerable work, and it is certainly necessary to investigate in each case—*i.e.*, for a special works—whether the possible advantages counterbalance this increased work which has to be done in the wages office.

One point of view which is often overlooked when arranging the work of the wages office has a more universal and greater importance than is generally recognised :—

> Everything possible should be done to make the flow of work through the wages office as even as attainable.

The nature of the work of this office has the opposite tendency and is readily affected by slack and rush periods. If, perhaps, a special investigation required by the management outside routine work coincides with a rush period, the staff is insufficient, and

either a generally uneconomical increase of the staff takes place or complaints about the inefficiency of the wages office arise. Therefore all measures which facilitate such special investigation should be welcomed, as, for example, the accounts of the individual workmen.

**6. The Problem of Mechanisation of Wage Booking Exemplified by the Hollerith Punch Card System as Applied to a Factory of Iron Barrels.** It may be clear from these discussions that the work of the wages office mainly consists in the different grouping of the same figures with a view to finding sums of payment, costs and statistics of various kinds. This can be done, and is done at all times, with the help of the simplest methods of arithmetic; the first four rules, as learnt in our school days. But the bigger modern industrial works become the more the number of workmen increases, the more tedious and time-taking the more costly and subject to error does this job become. It is therefore only natural that the human brain has tried for a long while to establish methods to mechanise this work, which seems to invite such a development perhaps more than any other office work. This tendency is certainly a sound one and any proposal made in this direction is worth serious consideration. There are, however, undoubtedly some dangers also connected with it which are often overlooked when first approaching this problem. Of these only two may be mentioned, the importance of which should be kept in mind continuously when choosing and introducing one of the various "systems" which have been elaborated.

It should never be forgotten that such a system cannot be anything else than a "tool" which is applied for doing the real job. It is therefore necessary first of all to make perfectly clear what kind of work shall be done, *i.e.*, to build up the organisation itself in the old and simple manner as if such a modern system did not exist; to find out the basic reasons which shall be a guide through the masses of figures pouring week after week into the wages office and frequently causing too much work for the persons occupied with the actual grouping. It may be that this stage of development is not actually achieved in practice as the working conditions are such that the use of one of the systems of mechanisation is a clear necessity from the first. In this case the organiser should at least outline on paper the whole organisation in detail without considering such a system of mechanisation, and *then*

consider the changes necessary for its introduction. This is the only manner by which to obtain those final results which are expected from the organisation.

That is also the best way to avoid the second mistake, of which it may be advisable to take particular notice, *i.e.*, that the system does not always remain what it should be, namely a " tool " and nothing else ; that it does not by itself begin to govern the work which has to be done and leads either to unnecessary complications, or—what is worse—to a handicap to production itself. As far as the organisation accomplishes one of the main demands that workmen and foremen shall be kept free from clerical work, it is not—or very rarely—possible completely to do without their help at the first booking of wages. Here the system of mechanisation must work so that it neither complicates this assistance nor obscures the reason for the various steps which may be asked for in the form of help from the men and the foreman. It is generally agreed that the woman with the best reputation is one whose reputation is not discussed, and the same applies to such a system. The best is that which does not call for comments in the shops because one does not feel that it influences the method of first booking in any way, and can therefore be chosen solely according to the convenience of production.

As already mentioned, there is a series of such systems elaborated and in use. Here only one example will be described, and it is chosen because it is the best which the author could observe in practice as fulfilling especially the demands outlined above ; but it should be kept in mind that it is given only as an example, and it is possible, of course, that there may be others equally valuable with which the author had no opportunity to become acquainted.

In order to render this description more useful for the practical man, it is given in a form which shows not only the system itself, but simultaneously its application in a special case, *i.e.*, in the factory of iron barrels, already mentioned. It will be seen that the importance of this system goes far beyond the limits of the wages office and the departments connected with it, but really embraces the whole internal organisation of the works.

The system used in this case was the well-known Hollerith System, which does not need a detailed description of the technical details after the many publications which may be found in

literature.[1] Here may be called to mind only the fact that the technical equipment consists of three machines : the punching

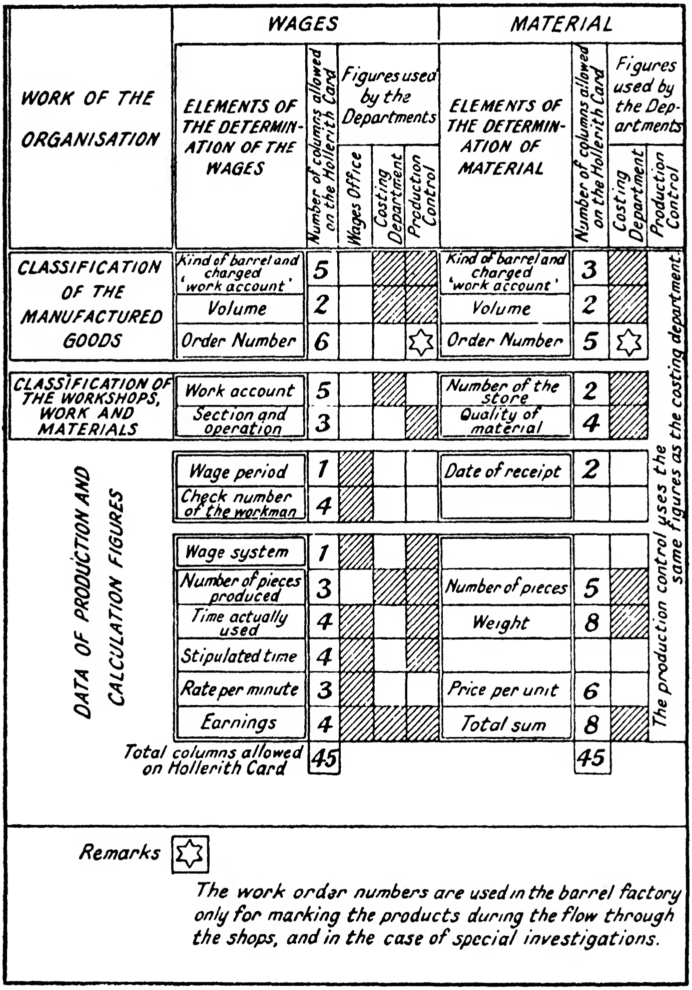



FIG. 22. The elements of works organisation.

machine or key punch, operated by hand, similar to a typewriter, which is used for " translating " the figures from the

[1] See, for example, Wheldon, " Cost Accounting and Costing Methods." London, Macdonald and Evans, p. 344, where the application of the Hollerith system to a plant rolling steel sheets and strips has been explained in detail.

original vouchers coming from the shops into punched cards ; the sorting machine and the tabulating machine, both operated automatically by means of electricity, the first sorting the punched cards in any desired manner, the second adding the figures of the individual groups and printing the results obtained.

Fig. 22 illustrates the elements of the determination of wages and material in connection with a system of piece-work wages expressed in time on the one hand, and the Hollerith system on the other hand.

The Hollerith cards have forty-five vertical columns of the figures 0 to 9 (see Fig. 24) and these columns must be allocated to all details, the collection of which is necessary for the departments concerned, *i.e.*, the wages office, the costing department and production control. This is shown in the two columns with the heading : "number of columns allowed at the Hollerith card" for wages and material separately and it may be noted that, in this case, it was possible to cover all details just by the forty-five columns. Of course, this cannot always be obtained, but it does not matter if one or several columns are not used. Difficulties may arise only if the total number of forty-five columns is not sufficient, but can be overcome completely by a second set of cards.

The shaded squares in the columns of the three departments indicate which of the departments is interested in the figures in question.

According to the first column of Fig. 22 the work of organisation can be divided into four parts concerned with :—

(1) The goods manufactured or the products,
(2) The raw material,
(3) The workshops, and
(4) The work.

As products and raw materials can be arranged according to the same principles of organisation, we deal here only with the products. A tripartition is therefore sufficient for the following considerations.

*Classification of the Products*

A barrel consists of body, ends and hoops. The hoops were so standardised that the same size of hoop could be used for various designs or sorts of barrels ; but body and ends had to be treated individually as no agreement of the customers to a standardisation of these parts could be obtained ; nearly every customer asked

for a special kind of branding of the ends or body, special plugs, thickness of the sheet, etc.

This fact led to production of the hoops in a special shop separated from the barrel factory proper. It was therefore possible to study the problems of both mass-production and individual production on this example.

(*a*) *Barrel Factory.* Four groups of barrels were produced; plain, galvanised, tinned and lead-coated barrels. Each of these groups may contain various designs or sorts of barrels, such as common barrels, pressed ring barrels, containers, riveted barrels, convex barrels, drums, tapered barrels, etc., and each of these designs or sorts can again vary in some details.

Each barrel is marked clearly by a figure of three digits: the figures of the hundreds column, indicating the group, *i.e.*, 5 = plain; 6 = galvanised; 7 = tinned and 8 = lead-coated; the figures of the tens column indicating the sort, *i.e.*, 1 common barrels, 2 pressed ring barrels, 3 containers, etc., and the figures of the units column the details of the design. The volume of the barrel was given in litres (1 litre = 0·22 gallon) and added to the barrel figure by figure of one or two digits showing the volume in 10 litre units. Thus, for example, a figure 651/22 denotes a galvanised convex barrel of design 1 and a volume of 220 litres.

(*b*) *Production of Hoops.* Similarly the hoops are marked: the figure of the hundreds column is here always 9, the figures of the tens column characterise the profile of the hoops, as they are used for various purposes, *i.e.*, roll hoops, internal and external hoops, beadings, strengthening hoops, and rings, corner beadings, etc., and the figures of the units column give the size of profile rings. Thus, for example, a figure 924/25 denotes an external hoop, a profile 33 × 8 and contents of 250 litres.

### *Classification of the Workshops*

A diagrammatic representation of the workshops is given by Fig. 23.

Each sort of barrel had to undergo some operations in the same sequence. Operations closely allied to each other were grouped in sections. Thus the following sections were obtained :—

(1) Production of hoops.
(2) Production of ends.
(3) Production of bodies.

(4) Production of convex barrels.
(5) Production of containers and pressed ring barrels.
(6) Galvanising, tinning and lead-coating shop.
(7) Assembly.
(8) Inspection.
(9) Repair shop.

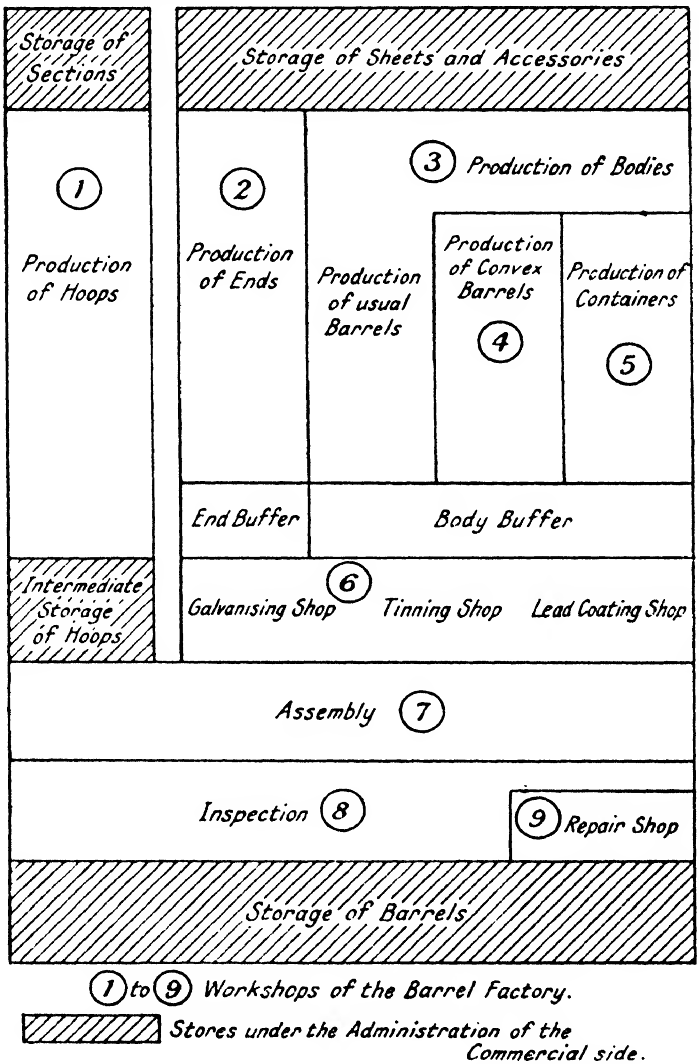



FIG. 23. Classification of the workshops.

As may be seen from Fig. 23, these workshops were enclosed by stores which were under the administration of the commercial side of the works, while the shops, of course, belong to the technical side. Requisition and delivery slips were necessary for obtaining material from and delivering goods to the stores. The buffer-areas for ends and bodies were of different nature : as the name indicates they were inserted with the intention that there should always be enough material for assembly and that stoppages could be avoided. These buffers, therefore, were not considered as stores and no exact book-keeping of issuing and delivery took place. They were not connected with the costing system and were under the administration of the technical side of the works ; but they were used as important places for the control of the production progress according to the original planning. The repair shop had the duty of correcting, as far as possible, all mistakes found in the inspection, *i.e.*, of the work, which is known in factory language as "touching up." One may say that it is wrong psychologically that the man who has caused a mistake or let it slip through unnoticed has not to correct it himself; and the justice of this idea is not to be denied. But the material which had to be handled in this factory was so bulky that it was preferable to put up with this disadvantage and in return to avoid as far as possible the transport of material against the flow of production.

### *Classification of the Work*

(*a*) *For production control purposes.*

Three main groups of work have been distinguished :—

(1) Production work.
(2) Auxiliary work.
(3) Touching up.

As may be seen from Fig. 24, three columns of the Hollerith card were free for denotation of the work, *i.e.*, the figures 000 to 999. The system of figures should allow the kind of work as well as the place where the work is carried out to be made perfectly clear. That has been obtained by the following method :—

(1) *Production Work.* The figures in the hundreds column denoted the section or workshop where the work was carried out, those in the tens and units columns, *i.e.*, 00 to 99, characterised the work itself in the sequence of its planned flow.

(2) *Auxiliary Work.* The figure in the hundreds column was here always 0, the figures in the tens column denoted the sections

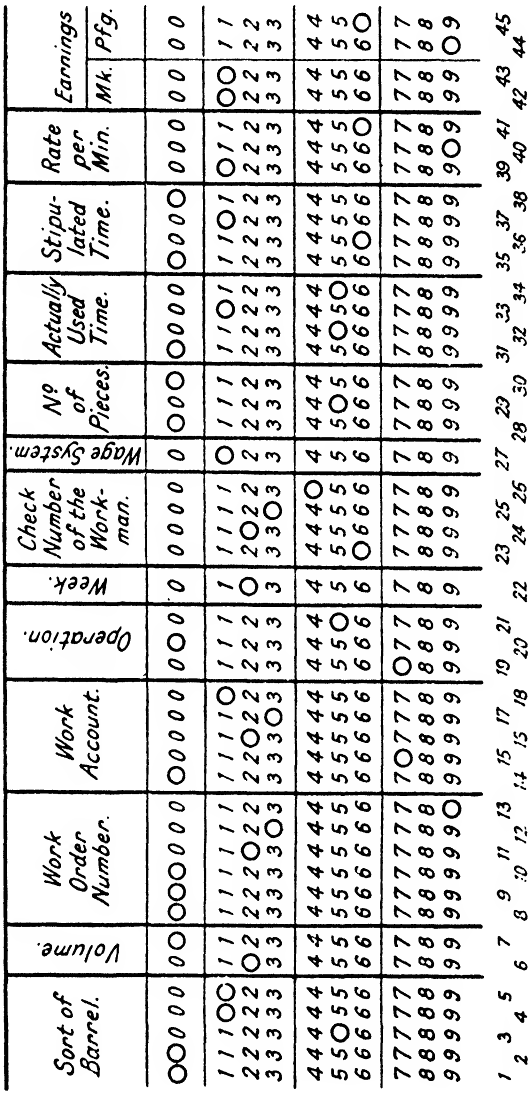



FIG. 24. Punched Hollerith card.

as explained above, and the figures in the units column operations which were repeated in the individual sections, *i.e.*, 0 = transport necessary for keeping the plant working; 1 = transport of

production material ; 2 = shop labour ; 3 = training of workmen ; 4 = general maintenance of the shop by its own workmen ; 5 = repairing machines ; 6 = lubricating machines ; 7 = work stoppages, etc.

It may be surprising at first glance that the transport of production material was classified as "auxiliary work," while it is, strictly speaking, certainly "production work." This has been done because the control of this item as a whole could thus be facilitated. It was the intention of the management from the first to have the auxiliary work in special view and to aim for close working from hand to hand between the individual sections. Therefore transport of any kind should be considered as something which should be reduced to a minimum ; and that could best be obtained by putting it under the heading "auxiliary work," while the costing point of view would have asked in this case for its classification as production work. Again the strictly logical aspect has been abandoned for psychological reasons.

(3) *Touching-up Work.* This was denoted in the hundreds column by the figure 9, in the tens columns the figures 1 to 8 of the sections in the same manner as the auxiliary work and in the units column the figures 0 to 9 as indicative of touching-up work in the sequence of the operations as planned.

A very strong production control could be obtained by this detailed classification of all operations possible, *i.e.*, a control of the wages necessary for producing the various sorts of barrels, divided into the individual operations ; the earnings per hour ; the ratio of time actually used to that stipulated ; and finally the auxiliary work and the touching-up work in all desirable details.

(*b*) *For Costing Purposes.* The detailed classification, as described under (*a*) for purposes of production control, has not been used for costing purposes. Here a simplification has taken place as the overhead costs have been allocated according to certain keys, as generally adopted ; and this allocation involves, of course, always some degree of inaccuracy. It would be useless to press for greater exactness in the determination of the direct costs, *i.e.*, those of labour and raw material, than it is connected with the allocation of the overhead costs. It must further be considered that the barrel factory was a part of a big works, where in each production department similar operations were

carried out; it was therefore possible to obtain sufficiently accurate costs by comparing the overhead costs as a percentage of the production wages. In these circumstances each single performance has not been marked by a separate figure; but equal and similar operations have been allocated to "work accounts," and these have been denoted by Hollerith figures. Four columns are used for this purpose throughout the whole works; the figures in the thousands and hundreds column mark the production departments, *e.g.*, in our case 7,000 = production of hoops; 7,200 = production of barrels; the figures in the tens and the units columns represent the "work accounts," *i.e.*, 00 to 50 repetition operations, applying to all production departments (for example, 20 = work of fitters, 31 = arc welding, etc.); 51 to 99 operations, peculiar to the production department in question (for example, 53 = work at the burnishing machines of the barrel factory). Therefore 7,231 means arc welding in the barrel factory.

After this explanation, the Hollerith card of Fig. 24 can be easily "translated"; it says: the workman, check-number 6,234, has arc welded (05) in the section assembly (7) during the second week of the period, 50 pieces plain barrels (511) of a volume of 20 litres. The number of the works order was 239. He worked on piece-work (1); the stipulated time was 610 minutes, and the time actually used 515 minutes. As the rate per minute was agreed at 1·96 Pfennig, the total earnings for this job were 610 × 1·96 = 11 Mark 96 Pfennig (1 Mark = 100 Pfennig = about 1 shilling), and they had to be booked to the "work account" 7,231, *i.e.*, arc welding in the barrel factory.

These cards, once punched, form an unchangeable permanent record; they can be mechanically sorted at any time and according to each classification indicated by one of the enumerated figures; the information punched therein can then be added or subtracted as desired and the result printed, and that almost automatically without brain work on the part of the person manipulating the machines, and with great speed. Moreover, if for a special investigation statistics are needed which are not made available in the usual course of the work, these can be obtained with nearly the same facility as if they had been provided from the first. The basic requirement is a suitable filing system for the cards.

It is obvious that these are great advantages against the usual

method without such mechanical equipment, advantages which will, of course, increase in proportion to the number of workmen, the variations of the products, and the more important and numerous statistics the management demands. On the other hand there are the costs of the installation and manipulation of this mechanical equipment to be considered in relation to possible ultimate economy. That certainly always needs special calculation ; for the author could cite an instance of a factory with only 500 to 600 workmen, where the Hollerith system was working very economically, although it is often declared that an economical result cannot be obtained in works with less than, say, 1,500 workmen.

CHAPTER IX

# THE IMPORTANCE OF TIME STUDIES FOR ECONOMIC CONTROL

## A. SOME PRELIMINARY AND GENERAL REMARKS

THE term " time studies " has been used repeatedly in connection with the explanation of wage systems on the previous pages, but is still so often misunderstood in practice, especially by people whose work is not directly connected with such investigations, that it seems worth while to insert a chapter which deals with the importance of these methods in modern production. This is done less to inform the reader exhaustively on the details of this work (an attempt that would exceed largely the space available for such a single item in the scope of this book) than to raise his interest and to entice him to study other sources, some of them mentioned in the course of the following considerations.

Do we really appreciate in our daily life how important " time " is ? An old adage says : " Time is money " ; but one could reply : " Time is more than money." Is it not possible to retrieve lost money ? How often has a ruined man rebuilt his fortune ? But the time of his life that has passed is gone irrevocably. We hear this truth from our first schooldays, learning when ten years old in the Latin lessons the verse : " *Veniet tempus mortis et quidem celeriter, et sive retractabis, sive properabis ; volat enim aetas* " ; but we do not understand it as long as we are young ! The child plays through the day, unconcerned in the evening that again a day is gone ; life lies before the young man in a series of years when he can work ; only at maturity he begins to feel how valuable each day, each week can be for his whole development, and he must approach the end of his career before understanding the full tragedy which lies in the word " time." Even if not in the scientific sense of Einstein, that is, if you like, a relativity of time, not an objective but a subjective one ; but is it therefore less important for a human

being ? Who has never experienced the sad truth of the words of the German poet :—

> " What you have refused to the moment,
> Eternity will not return ! "

But do we act in practical life according to this knowledge ? In particular, is the industrial employee always conscious of the importance of this fact ? A short walk through the majority of our works must convince us that it is just this most valuable good, time, which is treated very badly, idled away, neglected in a manner which shows that only a few people have a real understanding what they are actually doing. It is the importance of the time study that this consciousness is sharpened in all parts of the works, not only in the shops, but also in the offices, the knowledge of what time really means. Engineers know that power and material are indestructible ; that time is the most transitory of all that man calls his fortune, we forget only too easily.

## B. WHAT DOES THE TERM " TIME STUDY " ACTUALLY MEAN AT PRESENT ?

Time studies have changed since the days of Fred W. Taylor—that great man, perhaps one of the greatest engineers of modern times, who first made such studies systematically thirty, forty years ago. Although he himself may have recognised clearly which part of these studies was the most important, his pupils and successors have carried them out only too often in a more mechanistic manner, forgetting that not the time itself but the work done in the time, and the man doing it, should be investigated. The idea " time " must give way to the idea " work done in a certain time " ; instead of the " time study " we would better speak of a " work and time study."

The time study—to use, nevertheless, this short expression in the following discussion—is not, as the layman may believe, a pure determination of the time needed by a certain work ; it is :—

(1) An analysis of the work as it is done. The individual operations are examined and analysed as is thought desirable. The various times required for these operations are measured.

(2) A rationalisation. Any improvements in the methods of

working suggested by the information obtained is carried out, eliminating as far as possible delays and lost times.

(3) A time study measuring the times necessary for the improved or rationalised process.

(4) An analysis and criticism of the study under (3), especially by comparison with the original study under (1).

(5) Further utilisation of the results for future work of similar character.

It is valuable, although not necessary, to build up certain schemes, to show how to analyse the work and how to analyse the time ; and at the same time to standardise the nomenclature of the different parts of work and time. This makes easier the understanding in an individual undertaking, and, if the nomenclature is accepted by a branch of industry or even by the whole industry of a country it facilitates the changing of employees trained in this kind of work from one works to another for the benefit of the community.

## C. THE TIME STUDY AN AUXILIARY FOR PRODUCTION IMPROVEMENT

Time studies can, as already mentioned, be used as a help towards production improvement. We may distinguish between such improvements as require or do not require investment of new capital. In both cases the investigation of the present state of affairs from all possible aspects is important. As the process of production is mostly a combination of work done by (1) man on (2) material by (3) means of machines or tools, these three points of view should be taken into account. Questions of organisation, technology, engineering practice on the machines and tools and their maintenance, of the best manner of treating and leading men, etc., must be answered. If, as a result of the investigation, it is found necessary to buy new machines, new tools, to enlarge the shops or even to build completely new ones, the basic facts and figures can be developed according to these investigations and can form the foundations of enquiries for supplies of new equipment. Often the result is only small individual improvements in production, but they may sum up and finally give an increase of profit, an improvement of the whole atmosphere and of the spirit in the shop, which astonishes the investigators themselves.

Of course, the necessity for these improvements is mostly evident as soon as they are found out by work and time studies. Sometimes they are even well-known to workmen and foremen. But if one asks why they are not carried out, no answer or only an evasive one can be given. It is only when the systematic carrying out of such studies shows the damage done by such continuous toleration of old and bad habits or arrangements that actual remedy takes place. Innumerable examples could be given for such cases ; here may be mentioned the rational arranging of a working programme of a plant, *e.g.*, avoiding of frequent changing of tools ; the improvement of sharpening of tools on lathes, saws, etc., by the organisation of a common tool room for a number of workshops ; arrangements of a general transport time table in big works, etc.

## D. THE TIME STUDY AS BASIS OF A FAIR WAGE SYSTEM

This point has already been dealt with in the preceding considerations, but may be repeated and partly extended for completeness purposes.

Theoretically there is no fair wage system as long as the work of the men cannot be measured as one is accustomed to measure weight, or dimensions, or temperature, etc. It is known, however, that no such measure of human labour exists at present, and that it will not be at hand until physiological and psychological science is much further advanced. Therefore one has to be content with the nearest approach to measuring human labour, and that is the working time.

Wage systems in use are mainly the hourly fixed rate and the piece-work wage, nearly all others being unfair, either to the men or to the works. Every piece-work wage should be equal to the average time required for the work, multiplied by the hourly earning of the workman in question. The latter is mostly regulated by agreement between the employers and the employees. The first factor, however, can be determined by different methods, more or less connected with what we have called time studies, *i.e.*,

(1) Estimation.
(2) Calculation.
(3) Time studies proper.
(4) Comparison.

Estimation is the oldest and simplest method and is, in fact, often used unconsciously by those who even to-day deny the importance of the modern determination of working time. Its accuracy depends on the experience of the estimator and the care with which he does his work. The use of this method can only be justified in simple cases, and only then by first analysing the job into parts which may be estimated separately. The old estimation in the lump or according to rule of thumb must be condemned in all circumstances.

Calculation, the second method, is possible only for the main time on machines. Special mathematical formulæ have to be developed for each kind of machine, which mostly contain factors depending on the quality of the material, the tool, and the dimensions of the work piece.

The time study method is already characterised sufficiently. Here may be added only that the accuracy with which this method must be carried out varies considerably according to the circumstances in which the work investigated takes place. It is not true that the time study man calculates always in tenths or hundredths of minutes; he must possess what one may call "percentage thinking," really sense of proportion, and use common sense in applying the method.

Comparison is not a fourth method in the strict sense of the word, but a combination and extension of the three others in collecting and arranging working times as found by them, with a view to finding out by interpolation the time required for manufacturing similar articles which differ in size.

## E. TIME STUDIES AND INDUSTRIAL ACCOUNTS

If we call to our minds—what can be considered to-day as common knowledge—that the value of any kind of product or saleable good depends on the amount of man's labour contained, it is not astonishing that time, one of the most important measures of labour, is seen to be more and more a leading characteristic of modern industrial accounts. One has only to remember the *rôle* that standard data play, and that it is almost impossible to obtain reliable standards without time studies of any kind, and one will realise that actually industrial accounts cannot give a real picture of the building up of costs without the use of this auxiliary.

As problems where these standards are used may be enumerated: determination of effective capacity, labour cost control, the comparison between standard and actual overhead costs, etc. There will be ample opportunity in the course of the discussions forming the contents of this book to point out the importance of accurate time studies in connection with industrial accounts; therefore these hints may be sufficient for the moment.

## F. TIME STUDIES IN CONNECTION WITH INDUSTRIAL PSYCHOLOGY

Psychological knowledge has brought about a great improvement in the attitude of modern management; it is, however, essential that the man who wishes to carry out this work in the right manner should experience a change in the whole spirit of his relations to workmen and work. The connection between the work to be done and the human being who has to do it must be recognised, and the necessary conclusions drawn from this fact.

Also in technically well-organised undertakings considerable differences between individual workplaces and working methods can be found for the same job, resulting in different success. It has to be investigated why that is so.

There may be many reasons for these differences of which only those based on the different individuality of the workers, which cannot and should not be suppressed, will be justified. Suitable methods of training should be evolved, which raise at the same time the willingness to work and remove any disharmony amongst the workers. Actually the variations in the performance of human beings are much greater than is usually supposed. Practice in modern workshops helps to smoothe this fact, sometimes only veils it, but cannot eliminate it. It is necessary to find out how far an application of methods of modern psychology will help to show the most practical way of carrying out this work, without doing any harm to the personality of the workmen. Here may be mentioned as such methods, *inter alia*, analysis of occupation of trade, best arrangement of the workplaces, development of vocational tests, training after starting work, and supplementary and practical instruction later on. All these methods can best be based on careful work and time studies, arranged for the special purpose in question.

## G. SUMMARY AND CONCLUSION

Looking back to the various items we have dealt with we recognise that it is nearly impossible to maintain in practical life the separation we have used : improvement of production, a fair wage system, industrial accounts, industrial psychology, these are all branches of works economics so closely connected with each other that it may be possible to treat them separately in such a general survey, but in the shops these things must be combined, all the different aspects be considered simultaneously, and the best compromise between them must be found out ; for only too often they make conflicting demands, and of all possible solutions the practical optimum has to be selected.

The time study is a connecting link, the common basis ; therefore it does not only fulfill the individual purposes mentioned, it leads the people concerned consciously or unconsciously to what is—unfortunately—so often missing in modern works, co-operation. It is one of the bad consequences of the division of labour, this mark of our modern development, that it is so difficult to co-ordinate the work of so many different persons, different in profession, education and training, to one purpose, to the best of the common works. They all, the engineer and the commercial man, the draughtsman and the production engineer, the salesman and the accountant, they all see a mirror of the results of their work more or less in time studies. Therefore, if these investigations are carried out in the right spirit, correct but not exaggerated, showing the way without presumption, in fairness to all concerned, they can develop to a very useful mediator between the different interests and become the creator of the spirit of co-operation in the works, which is and will always be the first condition for real success and therefore the most important asset of the undertaking, although it cannot be shown in £ s. d. in the balance sheet.

## H. SOME EXAMPLES OF APPLICATION OF TIME STUDIES IN IRON AND STEEL WORKS

This general discussion on the importance of time studies to economic control of industrial works may be further illustrated by some examples where these modern methods have been applied with good success in iron and steel works. The first is an

extract of the report of the Rolling Mill Committee of the Iron and Steel Industrial Research Council of the British Iron and Steel Federation,[1] the second has been taken from the author's own experience and the third is an extract of an investigation carried out some years ago by one of his pupils under his responsibility.

**1. The Report of the Rolling Mill Committee of the Iron and Steel Industrial Research Council.** This report refers to an examination of three rolling mills :—

(*a*) A steam-driven 36-in. cogging mill.
(*b*) An electrically driven 36-in. cogging mill.
(*c*) An electrically driven 30-in. slabbing mill.

The course of the reports in all three cases is almost the same ; after a short introduction a description of the mill plant and their products is given, the procedure of the studies is explained, their results are interpreted and standards derived and finally the application of these standards is shown. Of course, each of the three plants has its peculiarities and, therefore, each of the reports shows different details, but the general course follows these logical lines.

In the first case the analysis of the studies is carried out in two stages ; the variations in the rolling times are examined on (*a*) individual products under different working conditions ; (*b*) different products. From (*a*) the following conclusions are drawn :—

With satisfactory soaking and correct rolling temperature and with steam pressure over 75 lb. per sq. in., it is always possible to follow a definite pass specification and to roll the same product in approximately the same time. Steam pressures below 75 lb. per sq. in. are definitely unsatisfactory. Even with adequate soaking and correct rolling temperature, a fall in steam pressure to 60 lb. per sq. in., *i.e.*, 80%, can increase the total rolling time by as much as 35%. Inadequate soaking and rolling temperatures below the optimum for the particular quality of steel being rolled have a marked effect on output. While for the most part different shifts adopt the same pass specification and draughting for the

[1] "The Application of Time Study to Rolling Mills." Published by the offices of the Iron and Steel Institute, 4 Grosvenor Gardens, S.W.1. 1938.

same product under optimum steam and heat conditions, and also meet non-standard conditions in similar ways, differences do sometimes occur which obviously influence the output.

For the second case may be mentioned as most important conclusions :—

Whilst under optimum operating conditions, steel quality has no very marked effect on rolling practice, rolling times are somewhat less for low, than for high, carbon and alloy steels. The number of passes bears a relationship to ingot and bloom size which is best expressed as a stepped function of the ratio of these two factors, *i.e.*, elongation. Manipulation time is generally directly proportional to the number of passes employed, net rolling time is a definite function of elongation, or, for the same type and size of ingot, a definite function of the bloom cross-sectional area. Whilst the bloom shape may affect, to a certain extent, the relationship referred to, the ingot type has, with few exceptions, no influence on the number of passes, net rolling and manipulation times.

Based on these conclusions standard times may be determined and selected, the application of which makes possible a control of the plant utilisation and mill performance which can scarcely be obtained by any other method. They are expressed by two terms :—

Cogging performance =

$$\frac{\text{Total shift standard time (min.)}}{\text{Total shift working time—Delays (min.)}}\%$$

and, for an eight hours shift with a statutory break of thirty minutes plant utilisation or overall performance =

$$\frac{\text{Total shift standard time (min.)}}{\text{Total shift working time (450 min.)}}\%$$

Although under present working conditions all improvements could not be obtained which were possible at a plant in which the various parts are in better balance—soaking pits, cogging mill and angle mill—the steps of improvement, based on the knowledge gained by the time study, resulted in an increase in output of 12% or 340 tons per week.

During the investigation of the second plant, an electrically

driven 36-in. cogging mill, new rolls unfortunately had to be installed, and consequently it has been necessary to divide the study in two parts, the first representing more normal practice with the old rolls and the second giving a measure of the initial effect of the new rolls. Attention is drawn to four factors influencing the rolling times :—

(*a*) *Shift Performance.* Although different techniques were employed by the different mill teams, and even by the same mill team at different times, the total rolling times were very comparable, which would suggest that these times were closely approaching the minimum possible value.

(*b*) *Soaker Treatment.* The rolling time obviously increases with decreasing soaking time ; there is, however, an optimum soaking time, for instance six hours for cold ingots in the plant in question, which has to be regarded as a suitable compromise between the opposed economic demands. A certain relationship could also be established between the bloom temperature and the net rolling time, for instance, in a special case, an increase of time of 0·25% per 1° C.

(*c*) *Effect of Steel Quality.* It can be stated that average rolling times run against the carbon content ; but this tendency is not very pronounced and it is certainly correct that the Report is very carefully worded when giving figures for this relation. More experience has to be collected before reporting definite results.

(*d*) The relationship between elongation, rolling time and number of passes is shown in a monograph which gives a very clear survey of the connections between these figures as given by the investigation. This monograph was used to facilitate the selection of standard rolling times. Some examples are given showing how this selection is done and attention is drawn to the fact that the mill performance is not affected by the time necessary for the travel of the ingot chariot from the soaking pit to the mill, but that a waiting time of thirty seconds on the average has to be included between each ingot for wash heating.

The effect of the new rolls is an increase in the total rolling time, which amounts to between 10% and 65% for the different types of ingots rolled. The additional time is due to increase in both net rolling and manipulation times, but principally the latter. The increase in net rolling was due primarily to the skidding or

slipping of the rolls upon the ingot, while increased manipulation was usually caused by difficulty of introducing the ingots to the rolls. The application of the standard times thus developed takes place in the light of the data obtained in the first investigation.

The third section of this Report deals with an electrically driven 30-in. slabbing mill. Again a division of the investigation into two parts is made : the one and main part concerning rolling slabs, and the second rolling blooms. In the first, the same method of analysis was used as in the cogging mill investigation, *i.e.*, an examination was made of variations in the rolling practice and rolling time, as between successive ingots of the same product on the one hand, and as between ingots of different products on the other hand. It was possible to select standard pass specifications and standard rolling times for each product from the figures obtained by these studies ; therefore due regard has been taken of the number of ingots studied, the conditions under which they were rolled (*e.g.*, rolling temperature and heating) and the minimum and average times observed. As the mill was working well below maximum capacity during the period of the studies, the mill teams did not appear to be endeavouring to obtain the best performance. This was probably due to a total lack of incentive (*i.e.*, reduced tonnage). It was, therefore, decided to reduce all standard times by 10%.

In the second part of this section concerning rolling blooms by the slabbing mill the effect of variations in rolling conditions (initial rolling temperature, pass specification, operation) are again discussed as far as the comparatively small number of ingots allowed to draw conclusions, an analysis of the variations on the different products is given, and standard times are selected. An interesting comparison is drawn between the rolling of blooms in the steam-driven cogging mill of the first and in the electrically driven slabbing mill of the third investigation ; the net rolling times were lower in the slabbing mill, the manipulation times lower in the cogging mill, resulting in higher total rolling times in the slabbing mill.

As already mentioned the operation of the slabbing mill during the studies occurred when at a low capacity, obviously due to the supply of ingots and the capacity of the reheating furnaces. An increase in output therefore, due to the setting of time standards,

could not be put to effective use ; but that does not mean that the studies have been without importance, as the knowledge obtained will be very valuable for purposes of control, costing, etc.

In an appendix, some notes are given on experiments for the determination of power consumption of electrically driven reversing rolling mills. The difficulties connected with such investigations are explained, if they are not undertaken from a purely economic and costing point of view considering the supplied energy as an economic unit, but allocating the necessary power consumption to each ingot or section rolled. Nevertheless, these difficulties have been overcome in the experiments in question and some facts, found by investigations already published, could be confirmed, namely : (*a*) the carbon content of steel from 0·04% to 0·75% appears to have no appreciable effect on the power required ; (*b*) a fall in rolling temperature from about 1,160° C. to 1,100° C. involves, for the investigated qualities, an increase of power consumption of about 25%, and the curves indicate that this tendency continues down to 1,040° C. and up to about 1,180° C. to 1,200° C.

From a study of the report the following general conclusions have been drawn :—

(1) That the application of research into problems of production control, conducted principally by means of the stop-watch, will provide reliable standards of performance and show how plant utilisation can be increased.

(2) That a considerable difference was found to exist as between the best tonnage that could be produced and what was in fact turned out.

(3) That time studies have brought to light the necessary requirements to secure the best output under optimum conditions and a reliable method of comparing outputs obtained from time to time, irrespective of the ingot size and finished sections.

**2. Special Features of Time Studies at a Jobbing Rolling Mill.** The second example can be considered as a supplement to the first in so far as it is an investigation at an outspoken "jobbing mill," whereas the production of the three mills investigated by the Rolling Mill Committee is at least a class-, if not actually a

mass-production. It was the purpose of this investigation to find out whether it was possible to establish standard rolling times for planning and costing purposes in spite of a programme which covered ingots of more than 40 different weights, of more than 115 different qualities and more than 100 different finished sizes, not to mention the fact that the methods of teeming the ingots varied largely. All these various products were produced mostly in small batches according to customers' orders as it would have been economically wrong to work on a large scale into a warehouse and to despatch the material ordered from stock.

For the purpose in question only the "sequence time" is important, *i.e.*, the time from the beginning of rolling of one ingot to the beginning of the rolling of the next ingot. These times were measured and recorded by means of an instrument operated with the help of an electric contact by the chariot which carried the ingots from the soaking pit to the mill. Any stoppages and delays exceeding 3 minutes were recorded in a book and a distinction was made between stoppages (*i.e.*, standing still of the mill due to any trouble caused by the machinery, material to be rolled or the manipulation of the men) and delays caused by lack of working capacity of the mill, which was originally built for mass production and not very well adapted to the work now required. The mill programme, the diagrams of the recording instrument, and the book of stoppages and delays were the documents from which the standard rolling times could be derived. Over 15,000 ingots have been investigated, but the variety of the governing factors was so large that in spite of this large number of ingots and of the fact that comparatively few groups of weights, qualities and finished sizes were formed and only averages for these groups developed the whole investigation could be considered only as a "first step on the right way" with all the uncertainty that is invariably connected with such a new method. Still the results have been accurate enough to be in use in practice till the working conditions had changed considerably, *i.e.*, the composition of the orders in regard to the qualities to be rolled.

It is not intended to report in detailed figures what results were obtained as they are only useful for the works in question, but two features of general interest should be mentioned, the first confirming facts already stated in this book, the

second adding some new aspect to what has already been explained.

It has been found

| as the weight of an ingot increased | the sequence time increased |
|---|---|
| 18% | 2·6% |
| 68% | 16·1% |
| 77% | 20·0% |
| 104% | 32·3% |
| 236% | 132·0% |

The use of tonnage for all calculations with the exception of rough average estimates should therefore be abandoned once and for all.

The method of investigation was different from usual time study methods in so far as no special reports besides the diagrams of the recording instrument were used; for the mill programme as well as the book of stoppages and delays were kept continuously for production control purposes in exactly the same manner as they were used for this investigation. It was now the question whether a difference in the figures found by the new method (which may be called shortly "statistical") on the one hand and the usual time study method could be stated and if so how it could be explained. For this statistical method had such great advantages—no interference with or prejudice of the usual production, no specially trained investigator in the shop, the work of investigation to a large extent routine work that could be done by girls in the office after a few days' training,—that its use in similar cases seemed very commendable, if it could be proved reliable enough. Therefore a special investigation has been carried out for comparing the figures found by the two methods and the result was that the ratio of the figures found by the statistical method to those found by the usual time study method was 1·18, *i.e.*, the former were about 18% higher than the latter.

This difference, astonishing at first glance, could be explained as follows:—

(*a*) There are delays not included in the time studies but invariably found and unavoidable, generally known as "lost time." They are perhaps important in other forms of production

but usually small at such rolling mill plants, since the causes can be avoided when the work is done by gangs of men—one easily replacing the other for a short time. In the case in question these delays could be estimated at about 3% of the time found by time studies.

(*b*) As already mentioned, the book of stoppages and delays contained only interruptions of work of more than 3 minutes, but it was clear that shorter interruptions occurred which should have been avoided and therefore excluded from the standard time. These stoppages were estimated in the case in question to be not more than 5% of the time study times.

(*c*) The remaining 10% must be attributed to the fact that the mill in question was used as a " jobbing mill " and not as a mill for mass production, one ingot being influenced by the one rolled before or after. This fact, which came as a kind of surprise to the investigators during the work itself, may be explained in principle by Fig. 25. It represents diagrammatically the time for each operation for a number of ingots passing through different stages of manufacture. For each ingot one operation takes the longest time and is therefore the " bottle-neck." The sequence time for this ingot will then be the bottle-neck time plus the intermediate time between the end of this operation on one ingot and the beginning of the same operation on the next ingot. The sequence time in Fig. 25A for one ingot is 14 minutes, in Fig. B for another ingot of a different type is 9 minutes. If 10 ingots of type A and then 10 ingots of type B were rolled, the total time taken would be $(10 \times 14) + (10 \times 9) = 140 + 90 = 230$ minutes. If, however, ingots of type A and B were rolled alternately as shown in Fig. C, then it will be seen that the total time taken would be $(24 + 6) \times 10 = 300$ minutes, *i.e.*, $\frac{300 - 230}{230} = 30\%$ higher than in the case represented by Fig. A + B. Now Fig. 25 has to be considered as a purely schematic one, the differences being made larger than they are usually in practice in order to make the principle quite clear. An investigation of the actual figures obtained in the case at hand showed that this fact of jobbing work at the mill in question accounted for the 10% increase of the time study times. It was doubtful whether this figure of 10% could be reduced considerably because a better approach towards " mass production " could not be expected as long as the nature

of the customers' orders on the one hand and the working conditions of the plant on the other hand could not be changed in this direction.

Under these circumstances the standard times were made equal to the statistical times minus 5%, *i.e.*, the stoppages characterised above under (*b*). In order to avoid any misunderstanding it may

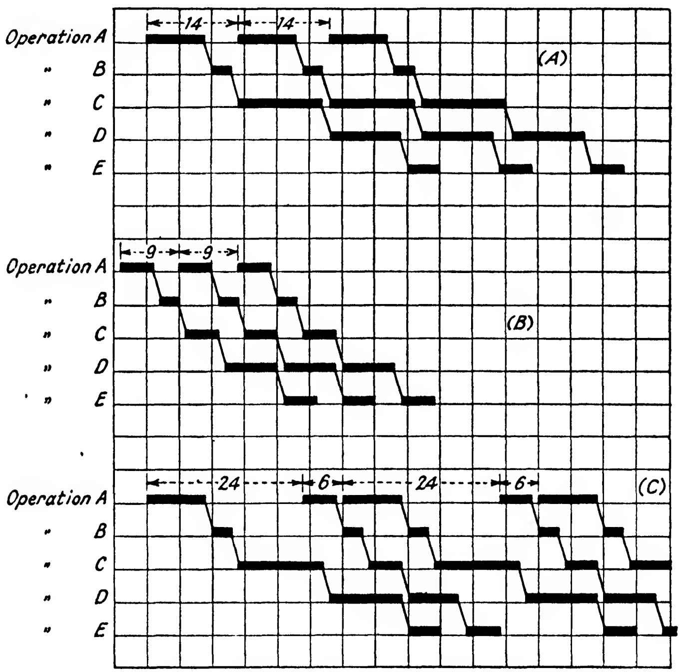



FIG. 25. Sequence time by alternate rolling.

be pointed out expressly that all " stoppages " contained in the " book of stoppages and delays " were already subtracted when developing the statistical figures, but the " delays " were not considered as they resulted from the lack of capacity of the plant and were therefore unavoidable. This procedure is the consequence of the definition of standard times as a " practical ideal," *i.e.*, the best which can be expected under actual working conditions of the plant in question. There will be opportunity to come back to this problem more in detail in the course of this book.

**3. Time Studies on Autogeneous Welding.** The third example deals with the possibility of defining working times for autogeneous

welding on lines somewhat similar to those generally applied in other metal-working operations such as turning, sawing, grinding, etc. It is chosen in the scope of this book on economic control in iron and steel because welding plants of the kind as dealt with in this investigation are often considered as an appendix to the iron and steel works proper. (As a matter of fact that was the case with the plant in question.) A second reason for the choice of this example is that it is concerned with nearly all aspects enumerated above as the main ends of time studies.

## *Description of Plant*

Plates as delivered from the rolling mill were cut to size on a planing machine, and rolled to pipes on a plate-bending machine. They were welded on nine hammer welding machines (see Fig. 26) arranged adjacent to each other, and controlled by a common

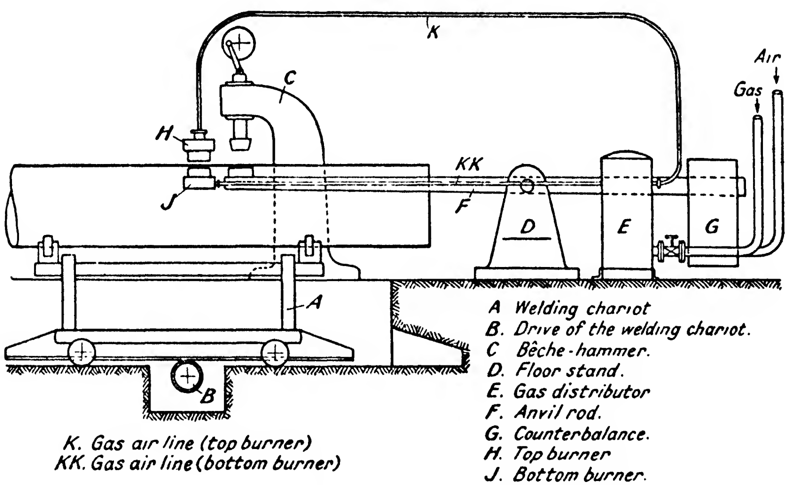



FIG. 26. Diagrammatic representation of a hammer welding machine.

crane. The burner, shown in Fig. 27, had top and bottom parts of similar design arranged opposite to each other and parallel with the anvil rod. As soon as a portion of the pipe was sufficiently heated by the burner it was brought by the welding chariot under the pneumatic hammer, and welded. A steam-jet blower cooled hammer and anvil rod during the heating turn, and removed the

slag during the hammering of the welded seam. Two men were necessary for operating the machine, the welder who controlled

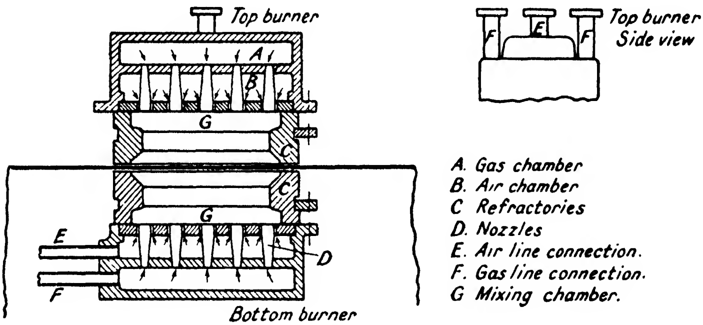



FIG. 27. Diagrammatic representation of an autogeneous welding burner.

the machine and the "wrench man" who kept the pipe in its correct place and moved it during the hammering.

### *The Production Programme*

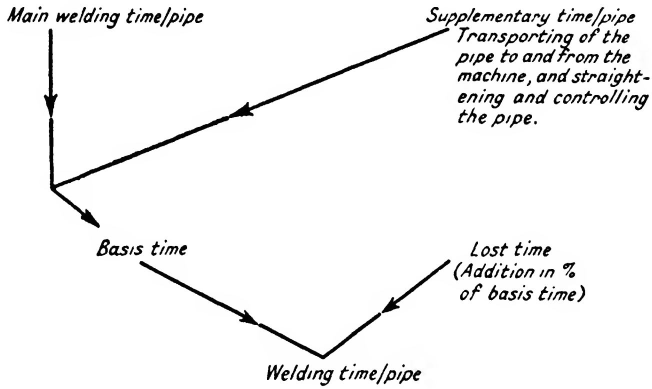
The pipes produced had internal diameters of about 16 to 32 in., thickness of plate 5 to 16 mm., and lengths of 23 to 26 ft. The welding machines were divided into three groups, A, B, and C, and the distribution of the various classes of pipes to the machines is shown by the following table :

| Class No. | Internal dia. in. | Thickness mm. | % of total production | Produced by machine No. | Machine group |
|---|---|---|---|---|---|
| 1 | 16 to 24 | 5 | 8 | 5 and 6 | *A* Light Machines |
| 2 | 16 to 24 | 6 | 12 | | |
| 3 | 16 to 24 | 7 | 20 | 2 and 8 | |
| 4 | 16 to 24 | 8 | 14 | 3 and 4 | *B* Medium Machines |
| 5 | 16 to 24 | 9 | 7 | | |
| 6 | 24 to 32 | 8 to 9 | 5 | 7 | |
| 7 | 16 to 24 | 10 to 12 | 10 | | |
| 8 | 24 to 32 | 10 to 12 | 4 | | |
| 9 | 16 to 24 | 13 to 16 | 15 | 1 and 9 | *C* Heavy Machines |
| 10 | 24 to 32 | 13 to 16 | 5 | | |

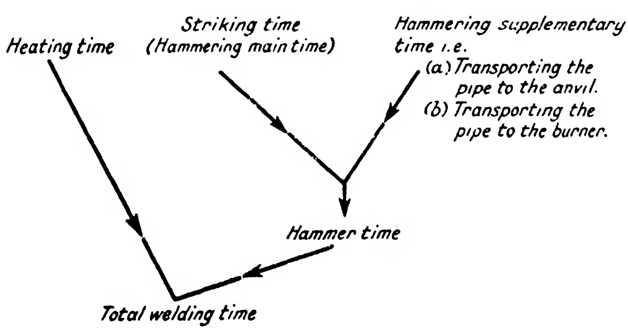
The investigation was limited to Nos. 1 to 5, 7 and 9—*i.e.*, pipes of 16 to 24 in. internal diameter, which represented 86% of the total production, and of a material normally used for such pipes with a tensile strength of about 22 tons per sq. in.

*Analysis of the Welding Process and the Necessary Working Time*

Several heats are necessary for welding a pipe of a particular length. To find out the influence of the different variables on the welding process and the working time, it is possible and useful to analyse this time as follows : The time for welding an individual piece of pipe during a single heat can be subdivided into :—[1]




Referring to the whole length of the pipe, it is convenient to use the sub-division :—




[1] The terms used are analogous to those explained in " The New Management," pp. 50–86.

*Limiting Factors and Their Influence on the Welding*

A close investigation of these individual times and the kind of work to be done indicated that the limiting factors or variables which influence the welding process can be considered mainly as :

The length of the pipe.

The length of the burner.

The number of heats per pipe.

From these factors result—

$$\text{The feed per heat} = \frac{\text{length of pipe}}{\text{number of heats per pipe}} \text{ and}$$

$$\text{The rate of utilisation of the burner} = \frac{\text{feed per heat}}{\text{length of burner}}.$$

The welding time is dependent chiefly on the length of the burner, but the length of the part that can be welded in one heat is limited in practice by the length which can be hammered while the material remains hot enough. The cooling rate increases with decreasing thickness of pipe, while the quality of the welding seam depends on the quality of the material used, and on the method of working which is again influenced by the length of burner. The effect of the burner is dependent chiefly on the feed and the rate of application. The length of heating time is affected by the quantity of gas used. In addition to the cost of special refractories in the burner, this quantity of gas is one of the main items of the process costs, and it is easily possible that with increasing burner effect the gas consumption increases so much that the final result is a decrease of economy.

These few remarks may be sufficient to indicate the limiting factors or variables which are related to each other in a rather complex way ; and it was the purpose of this investigation to determine numerically the mutual relations of these factors to such an extent that the method and the time of a special welding process could be determined with sufficient accuracy. It is not intended to give details of this investigation here, but rather to discuss the main features and to give the results.

*The Programme of the Investigation*

As already mentioned, only pipes of 16 to 24 in. internal diameter and of 5 to 16 mm. thickness have been investigated,

and the dimensions of the tested pipes have been taken so that conclusions could be easily drawn for any dimension between them. The investigations have been made with the usual burner of 10 in. length, and two burners of 13 to 15 in., respectively. Two men of an average capacity carried out the actual work for the experiments and the observations are always made on each man separately under the same working conditions, in order to be, as far as possible, independent of the human factor. About 10 pipes of each class and for each burner have been investigated and average figures formed from the reliable results. One machine of each of the three groups has been used for the tests. The course of the work and the individual times were investigated by time studies carried out in the usual manner, but as carefully as possible ; the quantity of gas has been measured by the orifice method. Tensile tests of the original plates as well as of the welding seam have been taken of each investigated pipe, in order to exclude mistakes arising from bad material ; also chemical analyses of each melt—*i.e.*, for every 10 to 15 pipes belonging to one melt, have been carried out. The finished pipes have been carefully inspected, and all welding defects accurately recorded. Finally, the pipes were subjected to the usual tests under hydraulic pressure.

*Evaluation of the Results of the Investigation*

The strong connection between the method of welding and the welding defects could be demonstrated clearly by the use of recording instruments which assisted, to a large extent, the usual time studies. An example is given in Fig. 28, the left parts of which show the production diagrams of two pipes of exactly the same kind, but the upper one with various defects in the welding seam, and the lower sound throughout. The reason for the defects can be taken directly from the diagram : either the heating was too long and the material burned, shown at 1, or the feed was too high, and caused open spots in the welding seam, shown at 2, or the feed was too low and the material burned by repeated heating which broke when hammered, as shown at 3.

The right parts of this illustration are graphs for finding the heating time per metre from the feed and the heating time per heat ; and it is clear that the heating time per metre is practically constant as long as the welder uses feeds within reasonable limits—

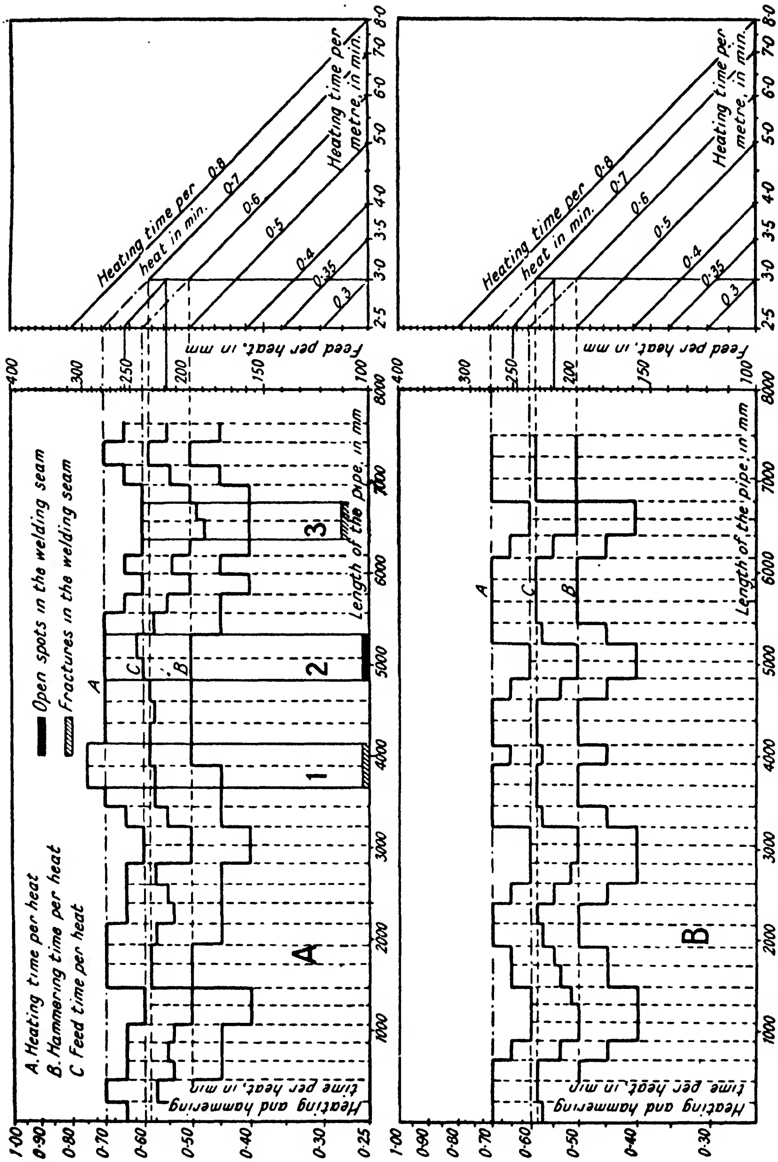



FIG. 28. Production diagram of the burner about 10 in. in length for the class 16 to 24 in. diameter and 7 mm. thickness.

a fact which is confirmed throughout all these investigations. This "regulating sphere" is different for different burners and different thicknesses of the pipes, and had to be determined for all important cases in practice.

Based on the experience obtained by these investigations the correct feeds, heating times and hammering times, as well as their connections with each other could be arranged in corresponding graphs, whereby the experimental results for the hammering time were verified by a comparison with the results of a theory of the hammering process published by an independent investigator.

In a similar manner supplementary and lost times have been determined, and the influence of the length of the burner on these times was especially investigated. Whilst such an influence could to some extent be stated on supplementary times, the lost times were practically independent and could be taken as an addition of 17% to the basis time for pipes of 16 to 24 in. internal diameter and 5 to 10 mm. thickness, and of 15% for the same pipes, but of 11 to 16 mm. thickness. This includes an addition for recreation of 5% which was found necessary in view of the special difficulties under which the men had to work, as, for instance, heat, noise, continuous attention.

As was to be expected, it was found that the consumption of gas per unit of time increased proportionately with the length of the burner, but this was lessened to some extent for thicknesses under about 12 mm. by the smaller degree of efficiency of the longer burners. It was, therefore, necessary to carry out a separate investigation in this direction.

### *Determination of the Economical Length of the Burner for each Pipe Class*

The wages and the costs of the gas consumed form the most important items of the proportional part of the total costs. The other items are either fixed costs or variable to such a small extent that they can be neglected for the comparison in question. By using the results of the tests and graphic methods of extra- and interpolation, for burners of lengths of 8 to 15 in. and pipes of 5 to 16 mm. thickness, the heating times per metre, the supplementary times per pipe, the feed per heat, and the hammering time per metre could be determined, and by combining these graphs and taking the working conditions of the burner of a length of 10 in. as basis, a diagram, Fig. 29, could be developed which shows the changes of costs when using burners of various lengths for pipes of different thickness.

As a result of this subsidiary investigation it was decided to use three different burners :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| For thickness | 5 to 6 mm. | a burner of | 225 mm. | (about | 9 in.) | long. |
| ,, ,, | 7 to 9 ,, | ,, | 250 ,, | ( ,, | 10 ,, ) | ,, |
| ,, ,, | 10 to 16 ,, | ,, | 375 ,, | ( ,, | 15 ,, ) | ,, |

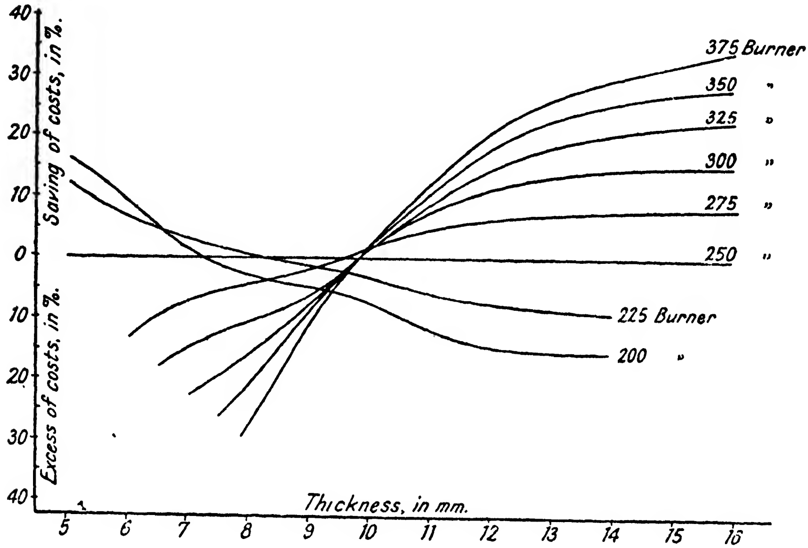



FIG. 29. Changes in costs, when using burners of various lengths for pipes of different thickness in relation to the cost when using the 10-in. burner.

The diagram seems to indicate that even a burner of a greater length than 15 in. should be used, but if that were done, the radiant heat would be too great for the workmen, and also other production difficulties would arise to interfere with the quality of welding.

### *Nomogram for Determining the Course of the Welding Process and Fair Piece-work Wages*

The relations between the limiting factors found by these investigations can be further used in developing the nomogram Fig. 30, which in each case enables one to determine the best working conditions and the resulting working time. This can best be shown by following up the drawn-in example : A pipe of 20 to

24 in. internal diameter, 9 mm. thickness and 25 ft. in length is to be welded. A burner of 250 mm. (about 10 in.) long is used,

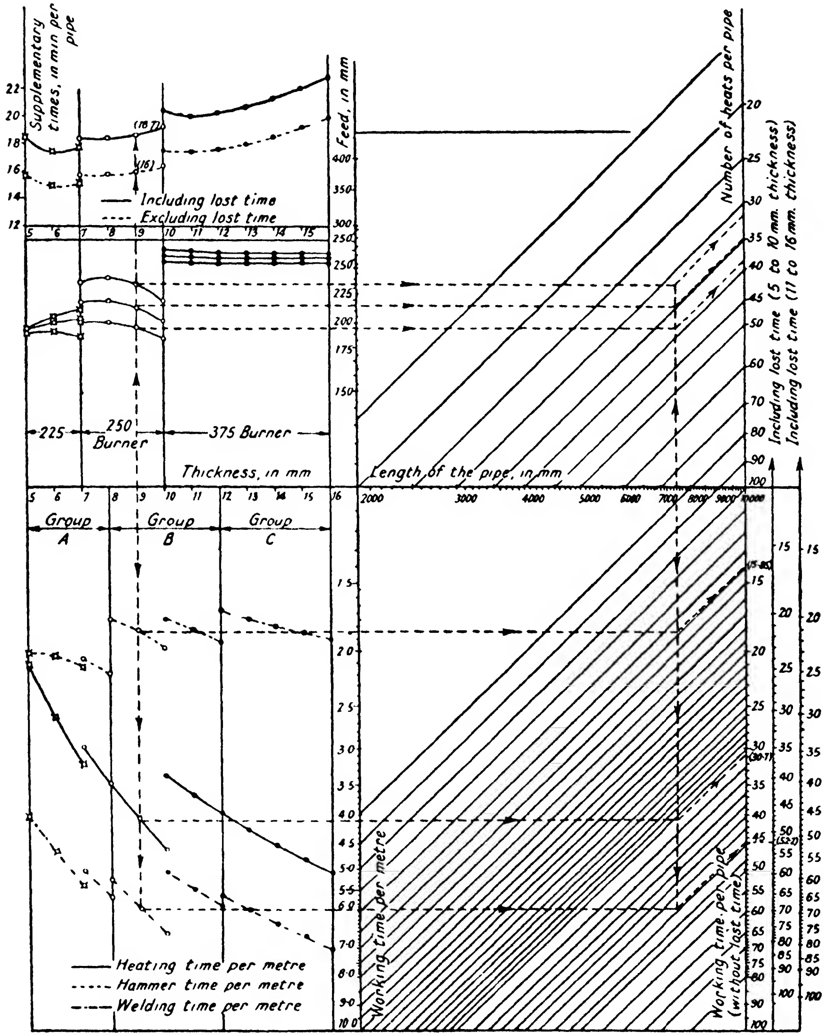



FIG. 30. Nomogram for determining the course of the autogeneous welding process and fair piece-work wages.

and a machine of group B employed. The feed will be chosen between 195 and 235 mm. (about $7\frac{3}{4}$ and $9\frac{1}{4}$ in.), and the number

of heats between 39 and 32. This will result in the following times :

Heating time per metre = 4·1 min.—*i.e.*, per pipe = 30·7 min.
Average hammer time per metre = 1·85 min.—*i.e.*, per pipe = 13·85 min.
Average welding time per metre = 5·95 min.—*i.e.*, per pipe = 44·55 min.

| | |
|---|---|
| Supplementary time ... ... ... ... ... | = 16 min. |
| Total working time, excluding lost time ... ... | = 60·55 ,, |
| Welding time, including lost time ... ... ... | = 52·2 ,, |
| Supplementary time, including lost time ... ... | = 18·7 ,, |
| Total working time, including lost time ... ... ... | = 70·9 ,, |

It may be of interest to see how these investigations have resulted in a system of production control, and what improvements could be obtained.

### *The Production Control*

When the working times for various classes of pipe have been stipulated, a comparison can be made between the work actually done and what ought to be done—*i.e.*, output can be controlled. But that alone is not sufficient ; it is necessary to find measures for the quality of the welding of the pipes and as the welding depends to a great extent on the ability and care of the man doing the job, this demand is identical with the application of a control system which permits the continuous supervision of the work of each single welder. For this purpose an elaborate control-plan has been developed which seems to be rather complicated and would probably have been uneconomical, had not the Hollerith system used for other purposes in the works in question proved a great help. The whole work of punching, sorting and tabulating the cards, as a basis of the statistics described below, took only about half an hour's work of one set of Hollerith machines per week.

To obtain the necessary figures of output, rejects, reasons of defects, etc., care was taken that no new forms were introduced into the shop, but the usual vouchers for wages, day work as well as piece-work, were so formed that they contained all fundamental figures if completed properly.

The welding work was done under the supervision of a foreman who induced the men to repair defective pipes without special payment as soon as he found out that defects had slipped in ; he

was also responsible for the correctness of the corresponding records. A second control was effected by a gang of men who were especially concerned with surface defects, and a detailed record was made for which the foreman of this gang was responsible. The finished pipes were tested under hydraulic pressure, and a third record resulted. Pipes found defective during the second and the third control were repaired and patched up by a separate gang of men in order to avoid transport reversals, which would disturb the flow of the sound pipes. A special record was prepared concerning this repair work. All these records were used to build up separate reports of the output for day and night shifts with the number of rejected pipes separated according to the various kinds of defects, etc., and all reports provided the various data for each class of pipes separately. But as the number of metres welded in one class cannot be compared with those welded in another class a "unit metre" has been taken as standard—*i.e.*, the metre of a pipe of 500 mm. (about 20 in.) internal diameter, 8 mm. thickness, and 7,500 mm. (about 25 ft.) length, and the results of all other classes were converted into "unit metres" by means of equivalent figures.

In order to find out the reasons for high or low output, good or poor quality of welding, etc., in one shift against another, similar data were prepared for each welder, and then shown in graphs and Fig. 31 gives an example. It shows the work diagram of a young welder over a period of nearly 1½ years—*i.e.*, from the day of starting work with comparatively small output and a high number of defective pipes, especially when a change of the class of pipes takes place; through a period beginning after about 5 months on similar work when the output is nearly as high as it ought to be, but a change of classes of greater thickness immediately results in a decrease of output and quality; up to equalised work and good welding of all classes with few defects at the end of the eighth month. This man, therefore, became a good welder in the comparatively short time of 9 months.

The work diagram of all welders combined, as shown on Fig. 32, gives simultaneously the total result of this whole investigation. It should be self-explanatory, and each addition would perhaps only diminish the impression that the research work accomplished

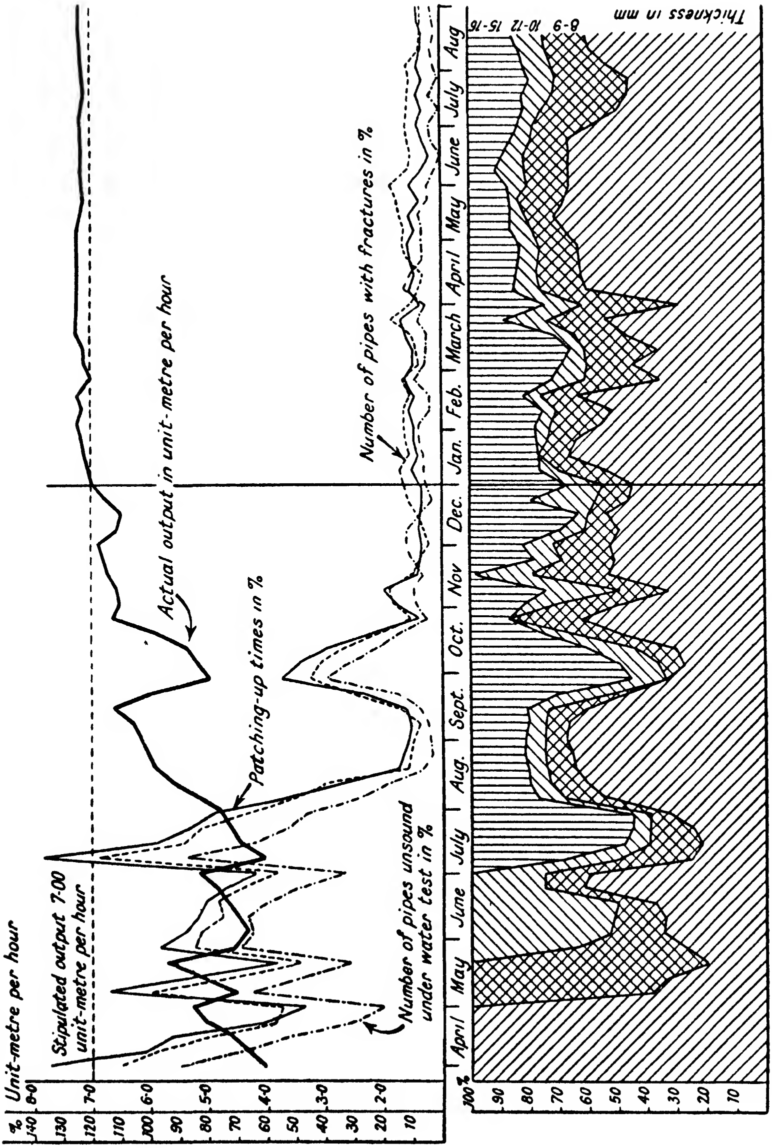



FIG. 31. Work diagram of a young welder.

in this case has not been in vain, since the output has been increased from 5·5 to 7·5 unit metres per hour—*i.e.*, 36·5% ; the patching hours went down from 40% to 6%, the number of pipes

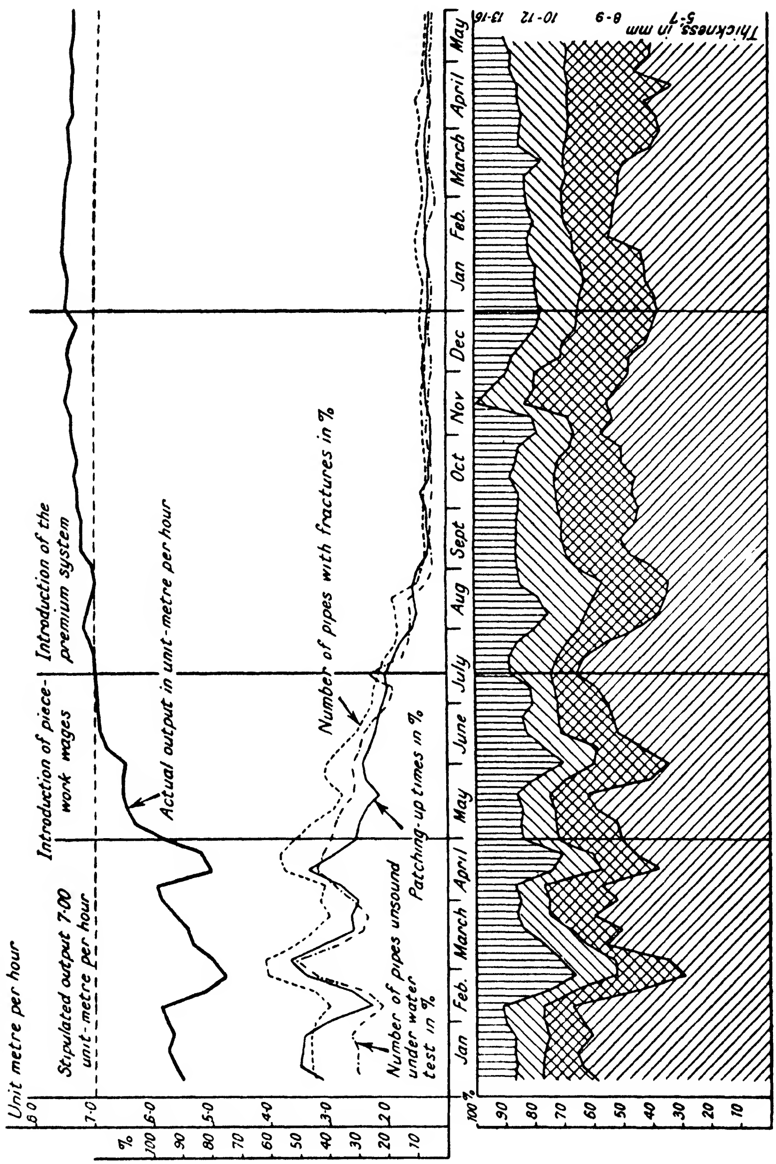



FIG. 32. Work diagram of all welders combined.

with fractures from 50% to 8%, and the number of pipes failing in the hydraulic test reduced from 35% to 5%.

Finally, it may be of interest that, in addition to the piece-work

system as recompense for increased output, these results have been obtained by applying a premium system as a reward for improved quality. The actual patching times as percentages of the stipulated total working times have been used as measures of quality, and Fig. 32, but particularly the production diagrams of individual welders, who have been connected with this kind of work longer than the man referred to in Fig. 31, show the favourable influence of this measure.

## CHAPTER X

# THE COSTING SYSTEM

After what has been said about "works accounts" and their splitting up into direct and indirect or individual and general costs on the one hand, and the real and calculated indirect costs on the other, a cost collection form, Fig. 33, will be understood without further explanation, but it must be emphasised that this figure gives *neither* an exhaustive list of types of costs *nor* of cost positions, applicable in a practical case without further consideration; it is merely a *scheme* illustrating the connection between the various items discussed earlier, and it has to be changed and formed according to the demands of the individual case.

When the allocation of the types of costs to the individual cost positions has been finished, it is necessary to go through each cost position so that the costs of the output of each position become clear. As already mentioned this "output" will not always consist of saleable goods; it can also comprise work done by one cost position or workshop for another, as in the case of the auxiliary departments; but from the point of view of such a department the work done in it has to be considered as its "output," even if it cannot be called so from the point of view of the whole works.

## A. VARIOUS FORMS OF CALCULATION OF COSTS

There are different forms of cost calculations and the choice of the form depends on the nature of the work carried out in the cost position or workshop in question, and also on the purpose of the calculation.

Where only one single product or operation is produced in units equal to each other, the calculation is very simple: the total costs in a certain period, *e.g.*, a month, are divided by the number of the produced units; therefore this method is termed "division costing."

More difficulties result if the products or operations of a shop

| | → Positions of costs<br>↓ Types of costs | Total amounts | Manufacture | | | | Trade | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Stores and stocks | Production workshops | Auxiliary workshops | Factory administration | Buying | Selling | Commercial administration |
| Direct costs | 1. Direct material | The figures in this column are obtained from "Accountancy" | | | | | | | |
| | 2. Direct wages | | | | | | | | |
| | 3. Other direct costs | | | | | | | | |
| Real indirect costs | 4. Indirect material | | | | | | | | |
| | 5. Indirect wages | | | | | | | | |
| | 6. Salaries | | | | | | | | |
| | 7. Insurances | | | | | | | | |
| | 8. Electric power and light [1] | | | | | | | | |
| | 9. Gas and water supplies, etc.[1] | | | | | | | | |
| | 10. Rejects | | | | | | | | |
| | 11. Advertising | | | | | | | | |
| | 12. Carriage in and out | | | | | | | | |
| | 13. Patents, etc. | | | | | | | | |
| | 14. Sundries | | | | | | | | |
| Calculated indirect costs | 15. Depreciation | | | | | | | | |
| | 16. Interests | | | | | | | | |
| | 17. Employer's drawings | | | | | | | | |
| | 18. Risks | | | | | | | | |
| | 19. Sum of rows 4–18 | | | | | | | | |

[1] As far as delivered from outside.

FIG. 33. Cost collection form.

are different and therefore the costs of the shop must be subdivided and allocated to these different bearers of cost. In this case some costs can be distributed directly as individual costs to the individual bearers of costs, in others the indirect or general costs must be covered by additions, mostly in the form of a percentage of some of the direct costs. This method is termed "addition costing."

This second form can again be divided into two different kinds of calculation according to the degree of difference between the individual bearers of costs. If this difference is very frequent and is such that one operation or bearer of costs is usually different from the others, each has to be dealt with as a single item to which costs must be allocated; in this case an order must be given indicating exactly the nature and the amount of the individual item, and this order is the basis for cost allocation. That is the reason why this kind of calculation is termed "order costing."

If on the other hand there is only a limited number of products being produced repeatedly from time to time, the basis will no longer be an order strictly indicating the nature *and* amount of the product, but the order will give only the approximate amount and determine merely the time during which this special class of product should be produced, leaving it to the workshop how much can really be finished in that time. We may call this "class costing."

Obviously "order costing" and "class costing" are both "addition costing," but the cost bearers or works orders are marked off differently. In the first case the quantity of the products, and in the second the working time is given as the limit. As "class costing" is simpler than "order costing," an endeavour should be made to substitute the latter by the former wherever possible, for example at rolling mills, when jobbing work is not the only kind of work, but stock orders are possible at least to some extent. In other cases, however, that is scarcely practicable, as for instance in the maintenance department.

A further simplification of the class costing system can be obtained by introducing "equivalent figures." They correlate the different costs per unit of the various classes to the costs of one of them, which is selected as the basic class; it is possible with the help of these equivalent figures to reduce the total output

of a department, say for a week, composed of several classes, to an equivalent output of the basic class, and as soon as this is obtained the problem of costing is obviously the same as in the case of division costing, *i.e.*, as simple as is generally possible. Of course there must be taken into account the work necessary for determining the equivalent figures, and in the selection of the method consideration must be given as to which case entails the minimum of work. It should not be overlooked that in normal times the variation of equivalent figures will be only small, so that these figures need be verified only at long intervals.

It must be left in each individual case to the discretion of the responsible person, how far the subdivision into classes shall go, or whether it is not possible to include similar classes in one common group as a single class. It should always be remembered that costing cannot be more than an approximate calculation and that exaggerated subdivision will increase the clerical work unduly. On the other hand, the grouping together of different classes always gives an average value, which depends not only on the individual values, but also on the ratio of participation of the various classes; and that the second influence can be very important is shown by the following example :—

A group may be composed of two classes *a* and *b* :

| | | |
|---|---|---|
| 1st month : | 40 *a* at £5 0s. 0d. . . | £200 |
| | 60 *b* at £4 0s. 0d. . . | £240 |
| Average | 100 at £4 8s. 0d. . . | £440 |
| 2nd month : | 80 *a* at £4 15s. 0d. . . | £380 |
| | 20 *b* at £3 18s. 0d. . . | £78 |
| Average | 100 at £4 11s. 7d. . . | £458 |

Although both classes have become cheaper, the average has increased, solely because the ratio of quantities has changed.

It will now be necessary to consider in more detail how these general rules are applied to the individual departments of an iron and steel works. As already pointed out, the technical departments can be divided into main, supplementary and auxiliary departments, and as the operations in one of these latter departments may again be costs in the main, supplementary or other

auxiliary departments, the cost of these auxiliary departments are discussed first.

## B. THE COSTING SYSTEM IN THE AUXILIARY DEPARTMENTS

From the point of view of costing, those cost positions which are called "factory administration" in Fig. 33 must also be considered as auxiliary departments. Distinction must therefore be made between the proper auxiliary departments, *i.e.*, plants for production of steam, electricity and compressed air, for the supply of water, the maintenance shops, the traffic department, the test house, and the general works service—and that part of the administration which is concerned with the affairs of manufacture as against those of trade or commerce.

The general works service may consist of the work of the porter at the works gates, the watchmen in the works premises, and in the shops, the fire station and fire brigade, sanitary and ambulance stations, air raid precautions, etc. The part of the administration dealing with manufacture may include the technical management, the purchasing department, cashier's office, accountancy and costing, consignment, invoice, control and statistical departments, wages and labour office, etc.

**1. The Operations of the Auxiliary Departments and Their Measurement.** Sometimes the measurement of the operations of the auxiliary departments is very simple, *e.g.*, the power plant, the water supply, etc., where the measures are 1 kwh., 1 ton steam, 1 ton water, etc. As these units are uniform for all shops where they are consumed, the simple system of division costing can be used.

The measurement of the work done by the maintenance departments is more difficult, as their work is so different and varied. Sometimes the working hours or the wages paid are used as the measure, but they both have defects for this purpose, as the value of one working hour may not be equal to that of another and this difference may be even increased in regard to the wages paid per unit of work done. It must be decided in the individual case, whether this defect can be tolerated or should at least partly be overcome by dividing the maintenance departments into various cost positions. It is usual to form at least three such positions : (*a*) work outside the shops, (*b*) work in the shops on

the machines, and (*c*) hand work in the shops, and then to subdivide (*a*) and (*c*) according to the various handicrafts, as fitters, erectors, electricians, plumbers, bricklayers, etc., and (*b*) according to the kind of machines used, as lathes, drilling machines, shears, etc. Each of these cost positions uses as measurements the working hour or the direct or "production wages," taking as such wages those being used for maintenance work for other shops. Indirect wages are in this case the wages of the foreman and the wages of the auxiliary workmen in the cost position, which cannot be attributed directly to the operation. In other words: in this case the meaning of the two terms "direct" and "indirect" must be understood from the workshop point of view and not from that of the concern. Maintenance work for the maintenance department itself can be dealt with in two different ways (*a*) and (*b*) as illustrated by the example below.

| | | (*a*) £ s. d. | (*b*) £ s. d. |
|---|---|---|---|
| Direct wages for other workshops | | 50 0 0 | 50 0 0 |
| Direct wages for own shop | | 5 0 0 | — — — |
| Total | | 55 0 0 | 50 0 0 |
| General costs or overheads | | 50 0 0 | 50 0 0 |
| (*a*) Direct wages for maintenance work for own shop | 5 0 0 | | |
| 110 per cent. overheads | 5 10 0 | | |
| Total | 10 10 0 | 10 10 0 | — — — |
| (*b*) Own maintenance indirect wages | | — — — | 5 0 0 |
| Sum of general costs | | 60 10 0 | 55 0 0 |
| General costs as percentage of direct wages: | | $\frac{£60\ 10s. \times 100}{55\ 0\ 0} = 110\%$ | $\frac{£55 \times 100}{50\ 0\ 0} = 110\%$ |
| Charged to other shops: wages | | 50 0 0 | 50 0 0 |
| 110% | | 55 0 0 | 55 0 0 |
| Total | | 105 0 0 | 105 0 0 |

As may be seen from this example the result is the same in both cases but the second method is simpler.

Maintenance materials can also be allotted to the shops by various methods: they are either charged first to the maintenance shop, which has to do the work of maintenance, and then transferred together with wages and overheads to the shop for which this work is carried out, or they are charged directly to the latter shop avoiding the maintenance shop completely. Although the

second method is, of course, simpler from the point of view of book-keeping, the first one should be preferred, as experience has shown that mistakes can be more easily avoided.

Order costing should be applied in the case of maintenance work which is important enough for the costs to be known as a whole, and the receiving shop should then be charged with this sum. Sometimes maintenance work is completely dealt with in this last and certainly very correct manner, even for less important work. This procedure involves the danger of an unduly increased clerical apparatus.

The "internal traffic" department comprises all transport from shop to shop within the works, but not in the shops themselves. It is not easy to find the correct measure of the performance of this department. Each kind of transport, *e.g.*, by locomotives, by steam cranes, by motor cars, etc., has to be treated as a separate cost position. The weight of the transported material is often used as a measure within such a cost position. It is obvious that that is not correct, as the length of the transport route must be of some influence. Therefore the "ton-mile" has been used in works of great area; but it is questionable whether the improvement is great enough to counterbalance the work connected with the refinement of the method; for as simple considerations about loading and unloading show, the "ton-mile" measure is also not correct. A third method is to develop a regular transport tariff based on special investigations as work and time studies, and to verify the correctness of this tariff by comparing the total amounts thus calculated with the total transport costs. This way is undoubtedly the best one, but also causes the most work; it would pay only under fairly stable working conditions so that no frequent additional investigations and changes of the tariff were necessary.

**2. The Allocation of the Costs of the Auxiliary Departments.** The measures of the outputs of the various auxiliary departments should be used for allocating the costs of these departments to the main and supplementary departments; frequently, however, auxiliary departments work for each other, and in this case the bill between them must be settled first. That may sometimes be difficult, as the mutual charges cannot be calculated correctly before the costing result of both is known for the period in question. Although it is possible to find a mathematically correct

solution for this problem, this is usually omitted as being too complicated and a method used which may contain an error, but one of no significance in the final result. This method is best illustrated by an example.

Electricity is necessary for steam production and steam for the production of electricity. Both are produced in their own power station. Before the mutual charging of one cost position to the other, the following figures could be obtained :—

| | Steam | Electricity |
|---|---|---|
| Total production . . . . | 10,000 tons | 500,000 kWh. |
| Various costs . . . . . | £1,750 | £150 |
| Supplied to electricity . . | 5,000 tons | |
| Supplied to steam . . . | | 40,000 kWh. |
| *i.e.*, of total production . . | 50% | 8% |

The further calculation now reads as follows :—

Approximate price per ton steam :

$$\frac{£1,750}{10,000} = 3{\cdot}5 \text{ sh} ;$$

| | | |
|---|---|---|
| assumed to be 3·7 sh. | | |
| 5,000 tons × 3·7 | | |
| cost of electricity supplied to steam | | £925 |
| | | £1,075 |
| 8% of £1,075 . . . . . | £86 | |
| | £1,836 | |
| | 3·672 sh/ton | |
| Costs per unit about . . | 3sh. 8d./ton | 0·516d,/kWh. |

The difference between the assumed and the calculated unit price of steam/ton is negligible.

The allocation of the electricity and steam costs now seems to be very simple, and that is really the case, if the consumption of these energies in units is known separately for the receiving shops or cost positions. Unfortunately that is not always the case because the insertion of meters is regarded as too expensive. If this is sometimes the case for steam consumption, it cannot be accepted as justified for electricity, where reliable and non-complicated measuring instruments are on the market. It will

be found that the sum of the consumed units is always somewhat smaller than the produced units and the author remembers a case where the installation of meters before the various cost positions, allowed only after a long struggle with the financial management, quickly brought about the discovery of conduction losses so great that the prime costs of the meters could be saved in a very short time.

After these considerations it can be left to the reader to find out the best key in each case, when allocating the costs of the auxiliary departments to the main and supplementary departments. It may only be mentioned that for the general works service and the administration costs, generally no other key can be used but the sums of wages, paid in the individual shops or cost positions. It should not be overlooked, however, that this key does not take into account the degree of mechanisation and therefore puts too high charges on the shops with a preponderance of hand work, a new indication of the repeatedly mentioned character of costing as an approximate calculation.

## C. THE COSTING SYSTEM IN THE MAIN AND SUPPLEMENTARY DEPARTMENTS

When the allocation of the costs of the auxiliary departments to the main and supplementary departments has been finished, or in other words the whole costs are collected in the final departments where saleable goods are produced, in such a manner that each of these final departments has a full survey of the costs for which it is directly or indirectly responsible, it then remains to find a way to connect these costs with the goods produced or the performances carried out in the corresponding departments. In principle this is done by relating the indirect costs in some way to the direct costs of the same cost position or to other items as closely connected with the individual products as the direct costs, *e.g.*, quality, weight, size of the products, hours actually worked on the product, etc. It has been pointed out already that these products or performances, also called bearers of costs, are generally characterised by works orders, which may either be limited as to quantity or to working time. In the latter case they are best calculated by means of the class costing system, which is especially applicable for the main products of the iron and steel industry As the costs attributed to a certain class of product

can often be divided into "individual class costs" and "general class costs," these considerations lead to the conclusion that from the point of view of a single main or supplementary department, relating the costs to the products or performances involves :

(1) Determining the cost positions within the department ;

(2) Determining and delimiting the bearers of costs, main products as well as by-products ;

(3) Determining the individual and general class costs and allocating the latter, and

(4) Calculating the by-products.

What is actually involved in the above may best be explained by quoting examples from the German source mentioned in the preface of this book.

**1. Blast Furnace Department.** Bearers of costs are the various classes of pig iron : open-hearth pig iron, basic pig iron, foundry pig iron, hæmatite pig iron, spiegel, ferro-manganese, ferro-silicon. There may also be various classes according to the different contents of manganese, silicon, etc. It is also important to know whether the iron is molten or in pigs, when leaving the blast furnace department. By-products are blast furnace gas and slag.

In many cases a blast furnace department will produce only one class of material. In that case a sub-division into cost positions would not be necessary from a purely costing aspect, but it is generally thought advisable for production control.

The following are recommended as final cost positions :—

Preparing and charging the burden.
Blast furnaces.
Hot blast stoves.
Casting house.
Removal of solid pig iron.
Removal of molten iron.
Removal of slag.

An auxiliary cost position—common departmental costs—should be arranged and if necessary subdivided, where these costs are first collected and then distributed to the final cost positions according to a key. "Standard wages" are usually taken as such a key, *i.e.*, the wages estimated for normal operation. This is accurate enough and even better than distribution according

to the wages actually paid which involve all the contingencies of actual practice, as explained later in detail.

Individual class costs, *i.e.*, costs which are separately charged to the various classes, are costs of the burden, of the coke, of the hot air, and the credit for blast furnace gas and slag. Burden and coke are determined by daily records made in the department; hot air and gas can be taken as proportional to the consumption of coke. The blast furnace gas used in the blast stoves is a part of the blast stoves cost position; but it is expedient to consider it as a part of individual class costs in order to obtain the total fuel costs in one sum, *i.e.*, costs of (coke + blast stove gas — blast furnace gas).

The following keys have been recommended for the allocation of the general costs to the classes :—

| | |
|---|---|
| Preparing and charging the burden. | Weight of the burden + charged coke. |
| Blast Furnaces . . . | Working time of the furnace. |
| Hot blast stoves . . . | Consumption of coke. |
| Casting house . . . | Production wages or production hours. |
| Removal of solid pig iron . | Wages or working hours. |
| Removal of molten iron . | Weight of molten iron. |
| Removal of slag . . . | Weight of slag. |

The key, wages or hours, is given for the removal of solid pig iron instead of the weight, for the reason that different costs may arise for the various classes according as transport by magnet crane is possible or not, or whether the pigs must be broken by hand, etc.

Questions concerning by-products will be dealt with later.

In the case of a basic Bessemer plant the mixer plant between the blast furnace and the steel melting shops is best treated as a separate main cost position. The product can be calculated by division costing.

**2. Basic Bessemer Plant.** For the grouping of classes the following can be chosen : quality of the steel (carbon steel, alloy steel, rail steel, etc.), kind of casting (in groups, single, etc.), shape of the ingots (ingots, slabs), weight of ingots (up to 20 cwts., 20 to 40 cwts., etc.), whether the steel is delivered solid or molten (duplex-process). This enumeration shows that a great many

variations are possible, and it is often desirable to look for simplifications. As one of these, it is recommended that the calculation of the costs of the molten steel and of the ingots be separated. The former can then be used for all ingots which only differ as regards shape. It should be noted also that variations in the saleable goods produced from the steel have an influence on the decision how far to go in the subdivision into classes.

By-products are casting scrap, used partly in the Bessemer Department as cooling scrap, partly in the open-hearth melting shop ; and phosphatic slag.

Cost positions of the basic Bessemer plant are lime-bins, converters, ladles, casting pits, moulds, removal of slag, spiegel furnace, manganese furnace.

Common departmental costs are dealt with in the manner described for the blast furnace department. Individual class costs are all positions of material, such as the charge for the converter, the amount of scrap, lime, other additions, the credit for slag, etc., the production wages in the casting pit, refractories of special shape and mould costs. The mould costs can either be used directly for costing purposes, if only a few classes in large quantities are produced and it can therefore be considered as sufficiently accurate to put the consumption equal to the supply ; or in the case of many different classes in small quantities an estimation must be made for each and the correctness of these estimations verified by means of a suspense account.

As keys for the allocation of the general costs these have been recommended :

| | |
|---|---|
| Lime bins . . . . | Quantity of lime consumed. |
| Converters . . . | Through-put (perhaps taking into account the different blowing times). |
| Ladles . . . . | Quantity of molten steel. |
| Casting pit . . . | Quantity of solid steel, or more accurately : production wages for labour costs and general costs, and weight of the solid steel for the remainder. |
| Moulds . . . . | Costs of moulds consumed. |
| Removal of slag . . | Quantity of slag. |

| | |
|---|---|
| Spiegel furnaces . . | Quantity of molten spiegel. |
| Manganese furnaces . . | Quantity of molten ferro-manganese. |

**3. Open-hearth Melting Shop.** The ingots are grouped into classes in a manner similar to that for the Bessemer plant, but the number of classes will generally be higher as the number of qualities is greater. Sometimes various methods of steel production are used, scrap-process, duplex-process, etc.; then a subdivision according to these processes is necessary. The separation of the calculations for the molten steel and of the ingots produced may again be advantageous.

By-products are casting scrap and slag.

Cost positions are: scrap-yard, furnaces, ladles, casting pit, moulds, heating of ingot heads, Harmet press, ingot-chipping, removal of slag, removal and storage of the cold ingots; and as an auxiliary cost position: general costs.

Individual class costs are: costs of the various materials, wages in the casting pit, costs of special refractories, costs of moulds, and chipping wages. Concerning costs of moulds the reader is referred to what is said above for the Bessemer plant.

The following are used as keys for the allocation of general costs:

| | |
|---|---|
| Scrap yard . . . | Weight of the solid charge. |
| Furnaces . . . . | Working time per heat.[1] |
| Ladles . . . . | Through-put quantity. |
| Casting pit . . . | See Bessemer plant. |
| Moulds . . . . | Cost of moulds. |
| Harmet-press . . . | Weight of production. |
| Ingot chipping . . . | Production wages. |
| Removal of slag . . . | Weight of slag. |
| Removal and storage of ingots . . . . | Through-put weight. |

The working time per heat is not an expedient key, if the melting shop has furnaces differing greatly in size, as a large

[1] This expression means the total time of a heat from the beginning of the charging to the end of tapping or the "tap to tap time." It is different from the "melting time" proper, which means only the time for melting down the charge. The "working time per heat" can be divided into fettling time, charging time, melting time, refining time and tapping time.

furnace has a bigger output per hour than a small one and the costs per hour are correspondingly different. For an accurate calculation each furnace size should be considered as a separate cost position, but a simplification could be obtained by the use of equivalent figures. For example: there may be furnaces of 100 tons and of 50 tons in a melting shop. The 100-ton furnace has an output of 12 tons/hour, the 50-ton furnace of 8 tons/hour. The second may be taken as the basis. Then each hour of the working time of the 100-ton furnace is equal to 1·5 equivalent hours, and when allocating the working times per heat to the various classes, the actual times of the 100-ton furnaces have to be multiplied by 1·5 in order to obtain a fairly correct distribution of the costs.

**4. Cogging Mill.** The grouping into classes may take place according to the quality of the steel, the form of the products (blooms or slabs), the size of the products (weight per yard or section) and to the kind of further working up of the material, *i.e.*, hot or cold working in the works itself, or direct sale to an outsider for subsequent working up.

By-products are scrap, slag and "shorts." While the method of dealing with slag and scrap will be explained when the costing problem of by-products is investigated as a whole, a few words may be added about the "shorts." They are rolled in the finishing mill in exactly the same manner as the other material and their value is in principle the same, but they decrease the output of the finishing mill and the possibility of using the finished products made from shorts is limited to a certain extent. These facts are of influence when estimating the value of the shorts, which has to be credited to the cogging mill and debited to the finishing mill. Methods other than estimation of this value will rarely be available; but this has to be done carefully, having regard to the particular working conditions, since undervaluation of the shorts brings about too high costs for the good blooms and *vice versâ*.

The following cost positions and corresponding keys of allocation have been proposed for cogging mills :—

| | |
|---|---|
| Soaking pits . . . | Through-put of ingots. |
| Supply of ingots to the mill . | Weight of ingots supplied. |
| Cogging mill . . . | Number of passes. |

| | |
|---|---|
| Shears . . . . | Weight of products. This key often used cannot be considered appropriate. Production wages would be better, or rather number of shear cuts. |
| Chipping of ingots . . | Production wages. |
| Removal and storage of ingots . . . . | Weight of ingots removed. |
| Loading . . . . | Weight of the loaded material. |
| Auxiliary cost position : | |
| General costs | Standard wages as key for allocation to the final costs positions. |

Individual class costs are the production wages of the cost position : chipping of ingots.

**5. Finishing Mill.** The kind of products is the obvious standpoint from which to group these products into classes, *i.e.*, blooms, billets, sheet bars, heavy or light rails, heavy or light sleepers, structural steel, steel bars, wide strip steel, etc.

These products can be subdivided according to the quality of the steel, the shape and size of section, the kind of further working up, *e.g.*, in short or long lengths, whether for the same works or for outsiders, etc.

By combining the above such a number of classes results that it is impossible in practice or at least not economical, especially with mills having an extensive production programme, to calculate the costs of each class separately. It is suggested that a middle course should be adopted, *i.e.*, to make the daily records in the shops as detailed as possible and to investigate in the costing department how far they can be combined for the calculation of a limited number of classes without endangering too much the correctness of the result for ordinary purposes. The daily records must, however, always be kept at hand in order to be able to make any special, more accurate investigation if necessary.

This middle course here proposed should also be adopted in many similar cases, where at present either the daily records are kept superficially because it would be too cumbersome to work through accurate ones or where these records carefully prepared and filled in in detail in the shops seem to cause the office more

work than is really necessary for the usual survey of the economic situation. The opinion is often expressed that the work involved in keeping these records so carefully is wasted if the costing department does not draw from them *all* possible conclusions. The fact is overlooked that the records have yet another no less important purpose—of securing effective production control. Furthermore, problems may arise in the course of the production where a special investigation based on these detailed records of the past can alone bring about a solution.

Cost positions are furnaces, mill, finishing bank, and storage and despatch.

Individual class costs are the production wages of the mill, of the finishing bank and of the storage and despatch, roll depreciation, and the production wages of the roll turning and grinding shop. Standard rates of roll depreciation are fixed for each class according to experience ; they are booked to a suspense account, to which the prime costs of the rolls are charged and the proceeds of broken rolls are credited. In special cases the economical rather than the technical life of the rolls may be the basis of the depreciation rates, *e.g.*, if the rolls can be used only for a special section—the repetition of which cannot be expected.

If the production wages of the mill per working hour are fairly constant, it may be possible to treat them as general costs and to allocate them in the same manner as the other types of costs, *i.e.*, according to working hours.

The furnace costs are generally distributed according to the charged weight, although that may be incorrect, because the influence of the steel quality on the heating is not taken into account ; but to find a better key might be difficult, and, this point should therefore only be taken into consideration in special cases, *e.g.*, where an extremely long heating time is essential, and then perhaps the use of equivalent figures based on the normal heating time will be helpful.

This enumeration of examples will be sufficient to show how each of the final departments has to be considered and how the figures obtained have to be grouped, in order to find a basis for calculating the costs of goods or performances produced in these departments. It may perhaps seem that too many examples have been given and that a shorter list would have drawn the attention of the reader more strongly to the important parts of

the discussion without troubling him by details perhaps interesting but too easily leading away from the main theme.

When these considerations are disregarded, the reason is that it may interest the expert to see how far the German publication recommends a refinement of the costing system in the departments in question. It will always be doubtful whether it is right to adopt all these suggestions, where simplifications can be made without hesitation and where a degree of accuracy beyond that represented in these examples seems to be necessary. Decisions in individual cases can only be made from the full knowledge of the special working conditions and of the purpose of the investigation in question. If a general remark is permissible, it is that often too much importance is attached to the refinement of the general costing system, whereas not enough use is made of the detailed investigations of special problems arising from the work in the shops or offices, or from the general business situation. The result is then that the clerical machinery is set up almost entirely for the first part of the work, and there is not enough time nor a sufficiently trained staff for the second task, which is frequently considered—at least at the time, when the results of such a special investigation are eagerly awaited—as the more important one. In such cases the whole costing system may be regarded with unjustified contempt—unjustified because the system itself is sound but was not organised to deal with the work expected of it. We will come back to these general remarks later in another connection.

## D. THE COSTING SYSTEM IN THE SALES AND DISTRIBUTION DEPARTMENTS

Having dealt with the manufacturing side, the trade or commercial side can now be treated. Many analogies can be pointed out. The selling and distributing costs correspond to the production costs. There are a number of types of costs and of cost positions; there are direct or individual, and indirect or general, costs. The latter have to be allocated to the cost positions according to the same principles as have been explained for the production side. Strangely enough this part of the costing problem has been comparatively seldom dealt with in literature, and even in practice the author has found that it is often neglected, or at least not considered sufficiently important for the necessary care to

be devoted to it. In these circumstances it is very fortunate that such an important body as the Institute of Cost and Works Accountants [1] has published a booklet, "The Problem of Selling and Distribution Cost Accounting," the main aspects of which can be used for the following discussion, as nothing is said in it which is opposed to the views of the present author. To be sure small compromises have to be made here and there; but readers know already that costing and accountancy should not be considered as a solid rock and the centre of strategy for leading industrial works, but as the flexible tool of an expert applied in the manner most expedient for the case in hand. This way of viewing things shows, as already mentioned, the limits of standardisation as drawn up for matters of costing and accountancy; on the other hand, it allows of an adaptability which facilitates the fixing of generally acceptable principles. There is no question that insufficient use is made of such a possibility. Hence, when a publication such as that of the Institute of Cost and Works Accountants appears it must be more than welcome, and it is to be hoped that the industry will draw the utmost possible advantage from it.

Here a few sentences may be quoted which should remove some doubts as to the boundary between production costs and selling and distribution costs, doubts which one finds sometimes in iron and steel works and which cause some uncertainty in the organisation.

"Production costs are the cost of making an article and of primary packing. Primary packing is intended for shop display, protection during the stocking period, and convenient handling by the consumer."

"The cost of packing for transport which may be determined by the nature of the transport or to facilitate bulk transport is a cost of distribution.

"The costs of distribution are incurred after the article is in a saleable condition and are the costs incurred in placing the article in the possession of the customer. They also include the costs of moving the article to and from prospective customers as in the case of goods on a sale or return basis. The cost of transporting articles to central or local storage in anticipation of sales or to facilitate sales is a cost of distribution."

"The cost of storage for finished goods is a cost of distribution.

[1] Registered office: 23, Queen Square, London, W.C.1.

Storage for finished goods comprises works storage, also intermediate and final storage depots for large towns or large customers."

" The cost of selling is the cost of endeavouring to obtain and retain the customer."

Attention may be drawn to the fact that there is no contradiction to the author's own definition of indirect material costs in these sentences, as the former is concerned with raw materials and semi-finished products, whilst the distribution costs apply to finished goods only. As may be seen, the stores for finished goods are considered as being outside the works proper. This may cause difficulties in cases where one and the same article is sometimes an intermediate product and sometimes a finished article, *e.g.*, ingots which can either be used for rolling in the works' mill, or sold directly to customers. In such a case a compromise must be made, perhaps by considering the ingot stores as a part of the production line if the majority of ingots are used as an intermediate product in the works itself, and as a part of the distribution if they are mostly sold to outside firms.

In any case, if the above definitions of the Institute of Cost and Works Accountants really represent the policy of other industrial works, there is no reason why the iron and steel industry should not conform, even if some initial change of viewpoint becomes necessary.

In order to show how similar the ideas contained in the booklet are to those developed in this book for production costs, a part of the " Control Chart suggesting Forms of Analysis for Selling and Distribution Costs," may be given (Fig. 34). It enumerates the suggested types of costs (nature of expenses), positions of costs (functions) and bearers of costs (location). It is not intended in reproducing this chart to induce any iron and steel works to subdivide their selling and distribution costs exactly according to this scheme ; on the contrary it should be remembered that this scheme is developed for general purposes and that it is not considered exhaustive. Therefore some items may be omitted and others added according to the special requirements of a particular case, but it offers a good survey of the possibilities of subdivision and explains to what extent this subdivision is considered necessary for costing as well as control purposes.

Before leaving this interesting publication a comment may be permitted. In the introduction it is said that certain groups of

| Cost analysis by nature of expenses | Cost analysis by functions | Cost analysis by locations |
|---|---|---|
| Remuneration<br>Direct Materials<br>Miscellaneous Expenses<br>Services<br>Fixed Charges<br>Freight, etc.<br>Duty<br>Packing Materials<br>Sales Promotion<br>Discounts and Allowances | Selling<br>Advertising and Sales Promotions<br>Transportation<br>Warehousing and Storage<br>Credit and Collection<br>Financial<br>General Administration<br>Miscellaneous | Customers<br>Towns<br>Counties<br>Countries<br>Markets<br>Agents<br>Representative Territories<br>Public Utility Supply Areas (Gas, Water, Electricity, etc.)<br>Departments such as Counters, Warehouses, Showrooms, Depots and Head Office Departments. |

FIG. 34. Extract of a control chart suggesting forms of analysis for selling and distributing costs.

the Institute of Costs and Works Accountants, when asked for contributions to the booklet, " have displayed some diffidence in being associated, as Cost Accountants, with Market Research and the measurement of the results of sales and advertising campaigns because they are of the opinion that these are exclusively within the function of Sales Management." The Sub-Committee responsible for the publication of the booklet strongly rejects that point of view and the present author wholly agrees. This is a complete parallel to the relation between the production man and the accountant as described in the introduction of this book.

The fact that any doubt can arise, even in accountancy circles, about the position which the accountant should hold in matters of selling and distribution cost accounting, shows how deeply rooted are the divergencies of opinion among those employed in the same industrial concern. We know what disastrous effects this fact can have on the prosperity of the concern, and nothing should be omitted that may bring about an improvement in this respect. The logical demarcation of the functions of each department is one of the best means of stopping disagreement between them ; it is obvious that cost accounting comprehends the whole concern, and it would be a bad mistake to deal with one part separately, perhaps in a different manner from that applied to the other parts, provided always, of course, that the costing department keeps to the position it should have continuously in mind : to be of service to the " final " departments of production and sales.

# CHAPTER XI

# BY-PRODUCTS

As the term " by-product " is mentioned repeatedly it seems expedient to interrupt the course of consideration somewhat in order to make clear how by-products should be treated from the costing aspect, even if thereby some matters which will be explained in detail later on, when dealing with job accounts, must be anticipated.

The term " by-products " must first be defined, for it is not always obvious in practice which of the two or more products of any given process should be considered as the main product, and which as by-products. One such case has already been mentioned: *i.e.*, the small iron and steel works which could only be worked during a time of economic depression because the profit of the cement of slag-stone factory counterbalanced the loss on the iron and steel works proper. Thus it is not impossible that in an individual case a blast furnace would be temporarily stopped if it were not that the blast furnace gas was needed for other processes in the works. But even in such a case, that product is termed a " by-product " whose production is carried out unintentionally alongside the product which was the original reason for constructing the plant. Hence it may be said, that by-products are those which arise when two or more products originate from one and the same source of production in quantities, the ratio of which cannot be influenced considerably, and of which one, the main product, can be considered as the result proper of the plant, while the others the by-products, are produced, so to speak, incidentally.

## A. WHY MUST COSTS OF BY-PRODUCTS BE FIXED ?

There was a time—not so long ago, perhaps at the beginning of this century—when it was concluded from considerations of this kind that the costs of by-products should be taken as nil, especially as, for example, in the case of blast furnace gas, the habit of

letting it burn away to waste had only just ceased. This fact is mentioned, not as a model, but to show the radical change of view which has taken place, for nowadays no serious costing expert would make such a suggestion, which calls to mind the famous saying of a so-called production engineer in respect of his factory's own power station: "The electric current does not cost us anything because we produce it ourselves." It is quite certain that the by-products cost something, the question is: how much? This is very difficult to answer, because it depends to a great extent on the circumstances of the particular case. It may be that even in the same case there are different answers according to the different purposes for which the cost figures may be used. Perhaps it is not superfluous to remind especially the technically trained reader that economics is not an exact science like mathematics, which has nearly always only *one* correct answer to a certain question.

The costs of simultaneous production of main- and by-products are determined as usual and as explained on previous pages, but how can and how should they be distributed over the various products? As already mentioned, the answer may be different according to the purposes of the cost distribution.

It may be called to mind that generally the costs of a product are needed as a basis;

(1) For determining an adequate selling price.
(2) For obtaining a short term production statement.
(3) For critical examination, whether a certain product can still be considered payable or not.
(4) For estimating the profitableness of new plants.
(5) For production control.

The last of these five purposes is of minor importance in the problem under discussion since the ratio of main product and by-products is generally constant. It is therefore sufficient to observe the development of the costs of the total course of production, without subdivision into the costs of the individual products.

Such a subdivision can also be omitted in case 2 as long as the quantity produced and the quantity sold or consumed is equal for the individual products in the same month. But as soon as one or more of the products have to be stored in order to overcome the differences between production and consumption, stock prices

must be developed, especially if these differences cause large fluctuations in the quantities to be stored.

For the other three purposes under (1), (3) and (4), however, the separation of the costs of the main product and of the by-products is essential, especially for the first.

Further, it is not right to say that this first purpose would cover the same ground as the second and the third : the first deals with an individual business or order, the second with the total results of the works or department during a certain period, and the third with the various classes of products, again during this period.

Without discussing in greater detail the other purposes mentioned under (3) and (4) some general remarks may be added on the problem under (1), *i.e.*, of using costs as a basis for the selling price. When the question arises whether a special order should be accepted for production the following four questions should first be answered : (1) What will be the costs of the works if the order is carried out ? (2) What will be the costs of the works if the order is not carried out ? (3) What will therefore be the additional costs caused by this order, *i.e.*, answer to (1) minus answer to (2) ? And (4) What increase in the returns can be expected from this order ? It is obvious that these questions cannot be answered sufficiently correctly in the case of the simultaneous production of a main product and of by-products, without using prices for the by-products based on their costs. Thus the difficulties of finding these costs must be overcome by some means.

Attention may be drawn here to the term " additional costs," a concept which plays an important role in problems of price policy and will be dealt with later in more detail.

Summarising these considerations it can be said that a way must be found to fix the prices of by-products and that the most important factor in the determination of these prices is the question of profitableness of the individual orders which must be answered before accepting these orders.

## B. THE FORM OF CALCULATION

There are two methods used in practice to distribute the total costs over the various products of the same process. In the first the one product is charged at a certain unit price which may be termed "charge price," the costs of this product being calculated by multiplying the number of units by the charge price. The result is subtracted from the total costs of the common course of production, and the remainder is the costs of the other product. This is known as the remainder method. In the other the total costs are allocated to the various products according to some key. Both methods have various forms. With the remainder calculation it is of importance how the charge price is chosen. Sometimes this is put equal to the selling price. That means that the total profit of the common course of production is given to the other product. When the charge price is lower than the selling price the profit is distributed between the two products correspondingly. When using the key method the choice of the key becomes difficult. One could use technical or economical characteristics. Of the former type there have been recommended, for example, the calorific value of coke, coke oven gas, etc.; but every engineer knows that there can be no logical connection between the costs of production and the resulting calorific power and that the various methods of disposal of the products influence to a large extent the economical value of the final product.

An example taken from the early practice of the author may illustrate this, even if it leads away somewhat from the problems under discussion. As an employee in a factory making large internal combustion engines, he had to make up a tender for such machines driven by blast furnace gas, and was happy to find that based on the figures of calorific value the comparison between (1) blast furnace gas directly used in gas engines, (2) burned under boilers and (3) coal at hand in the works in question and fired under boilers, gave a favourable balance to the first alternative. When he changed his position a year later, being employed by a company constructing central condensation plants, he proved in a similar tender that the first steam plant—*i.e.*, the proposition under (2)—was superior in economy. There is no doubt that both calculations were correct, as far as they went, but as in all these

cases much depends on the skilful choice and arrangement of the basic figures.

The longer one considers these problems, the more one must conclude that the allocation of costs according to technical figures representing the internal value of the products, cannot be founded on reasonable arguments ; but the case is nearly the same when taking commercial characteristics, *e.g.*, the market prices of the products as a basis. There is unfortunately also no logical connection between costs and market prices, and if one uses this key, it does not allow anything else but calculating the same percentage profit for both products. This result however can be obtained much more readily by comparing the joint costs with the sum of the proceeds.

It is obvious that there are as many objections as there are propositions and that it is almost impossible to give a general answer to the question. If the discussion is not to remain purely theoretical and therefore unsatisfactory for the practical man no other way seems to be open but to consider examples as they occur daily in iron and steel works, and to use them as guides in similar cases, or to draw general conclusions from them as far as that is possible.

## C. EXAMPLES

**1. Rolled Products and Scrap.** Nobody makes scrap intentionally. On the contrary this by-product is considered a loss and everything possible is done to decrease the quantity ; nobody would think for a moment of distributing the production costs in this case to main product and by-product ; they are entirely allocated to the former. The scrap is evaluated either at the market price if there is one, or according to the saving which can be obtained by using it in another department. It is obvious that in this case only the remainder calculation can be applied and it seems clear that all the supplementary costs connected with the conversion of scrap into a saleable form, or with the transport of the scrap to outside customers or another department of the works, should be charged to the rolling mill or subtracted from the credit note the rolling mill receives for the scrap. Even in such an apparently simple case, however, there may be difficulties as the next example shows.

**2. Open-hearth Steel and Slag.** The slag is a by-product whose value usually depends mainly on its iron content. It can be used

where the open-hearth melting shop is situated quite near the blast furnace. Lengthy carriage would offset this value and it would be more advantageous to dump the slag. As the slag must be removed from the melting shop, whether it can be used or not, it may be disputed whether the costs of removal should be added to the costs of the steel or subtracted from the value of the slag. The decision is of no importance to the costs of the main product as the remainder is in both cases the same. Nevertheless it is more correct to add the removal costs to the costs of the main product, at least in so far as they would arise even if the by-product slag cannot be used. Take, for example, the value of the slag at the blast furnace for its metal content. The prices of the ore and the melting costs are say 2s. per ton ; the removal of the slag to the dump may cost 2s. 6d. and to the blast furnace 3s. If the slag were charged with these last costs, its value would be at least 3s. even though the metal value of the slag were nil, *i.e.*, the slag would be too expensive for use in the blast furnace. Really, however, it is very profitable to use the slag in the furnace, as the costs of 2s. 6d. per ton arise in all circumstances ; the additional removal costs, if the slag is used in the blast furnace are only 3s. less 2s. 6d. or 6d. per ton, and its value at the blast furnace can be calculated as 2s. less 6d. or 1s. 6d.

**3. Basic Bessemer Steel and Phosphoric Slag.** The phosphoric slag resulting as a by-product from the basic Bessemer process can either be used in pulverised form as artificial manure or charged into the blast furnace because of its phosphorus contents. The market price of the pulverised slag and of ores of corresponding phosphorus contents decide which use is the more economical. The value of the phosphoric slag by-product is in the first case the market price of the pulverised slag minus costs of pulverising plus selling and distributing, and in the second case the market price of the corresponding iron ore. The higher of these values has to be taken when calculating the costs of the main product—steel—to find out the most economical use, but when calculating the costs of pulverising, selling and distributing, only those additional costs should be taken into account, which arise directly from the production of this artificial manure. These additional costs are that part of the total costs which is proportional to the output, while the fixed part of the costs, such as depreciation, salaries, etc., must be paid nevertheless, whether less or more slag

is ground. There is no reason to subtract these fixed costs from the market price of the pulverised slag; they are there as soon as the pulverisation plant is erected, and are therefore fixed costs of the steel production. An example may show this more clearly. The figures are all per ton.

| | | |
|---|---|---|
| Charge costs of the basic Bessemer steel | | 50s. |
| Proportional production costs in the melting shop | | 5s. |
| Total | | 55s. |
| Value of the slag: | | |
| Proceeds of the slag | 30s. | |
| Proportional costs of pulverising and packing | 8s. | |
| Value per ton of slag | 22s. | |
| 4 cwt. slag are produced per 1 ton steel | | 4s. 5d. |
| Proportional costs of the basic Bessemer steel | | 50s. 7d. |
| Fixed costs of the basic Bessemer steel | | 5s. 0d. |
| Fixed costs of pulverising, distributing and selling the slag | | 1s. 5d. |
| Production costs of the basic Bessemer steel | | 57s. 0d. |

This kind of calculation makes it impossible to decrease the value of the slag and therefore to use it in the blast furnace, if the melting shop is operating at less than normal rate and thus produces less slag; the fixed costs of pulverising the slag then increase per ton. If, however, the result of such a calculation is that it would be more economical to use the slag in the blast furnace, and the slag is nevertheless pulverised, the calculation of the production of the pulverised slag will show a loss and will draw attention to the uneconomical use of the slag.

**4. Pig Iron and Blast Furnace Gas.** The object of the cost calculation is the main product—pig iron; the value of the by-product, blast furnace gas, is expressed by a charge price from which the costs of the gas produced are determined and subtracted

from the total costs in order to obtain the costs of the pig iron. Again the remainder-calculation alone can be used; for keying the costs is senseless, as the blast furnace gas must be produced, whether it can be used or not. The question is what price can be chosen as a charge price? This is best done as with scrap according to the market price. Now blast furnace gas has no market price; hence nothing can be done but to use the market price of other fuel which could replace the blast furnace gas if the technical plant were at hand for its use. As may be understood from this last remark, this is not always a simple substitution of one medium by another with the use of proportional figures of calorific power and prices per unit, but needs sometimes the planning or at least a sketchy design of a parallel plant suitable for the other fuel, and a comparison of the profitableness in both cases. The danger of miscalculation in such circumstances has already been mentioned and great care must be taken if this method cannot be avoided.

Again some figures may make clearer the use that can be made in practice of these general explanations. The works may have a coke oven plant with superfluous coke oven gas which is sold at 1d. per 100 cubic ft. 400 cubic ft. of blast furnace gas may be equal to 100 cubic ft. of coke oven gas; therefore the blast furnace gas has a value of ¼d. per 100 cubic ft. On the other hand, if there is no superfluous coke oven gas, but the works have to buy gas for 1·2d. per 100 cubic ft., the price of the blast furnace gas should be taken as 0·3d. per 100 cubic feet. Here it is assumed that the two different kinds of gases can be used in the same plant without any technical change and that their value as fuel is almost proportional to their calorific value, *i.e.*, 1 : 4. Neither of these assumptions is always correct. If they are not, conversions may be necessary which change the above simple calculation into a fairly complicated one. Further the price of ¼d. and 0·3d. respectively are for the blast furnace gas, ready for use, *i.e.*, cleaned. The cleaning costs have to be subtracted in order to arrive at the charge price of the uncleaned gas. The cleaning costs must be divided again into proportional and fixed costs, as only the former should be subtracted in this case of additional production. Finally, ratios such as that assumed in the above example: coke oven gas to blast furnace gas equals 4 : 1, are not fixed. They change not only from works to works, but may

change in the same works at various times ; it is even possible that for two different complexes of questions in the same works and at the same time, different figures must be taken in order to do justice as far as possible to the different circumstances. Therefore the advice can only be given that decisions of this nature in costing questions should not be taken without constant consultation with the fuel engineer of the works, who would probably be the sole person having full knowledge of all the questions concerned and their connections with each other.

**5. Coke and Coke Oven Gas.** In this case the answer to the question, what is the main product, what is the by-product ? is more difficult. One has only to realise that what is practically the same plant is called " coke ovens " if situated in an iron and steel works, and " gas works " if a part of a municipal or public utility plant. In the first case the coke is usually considered the main product and the gas as a by-product ; in the second case the gas is the main product. But how many coke oven managers have already had the experience of the roles being suddenly changed ; the demand for coke decreasing, but the other departments of the same works arranged to a large extent to use coke oven gas, asking for an unchanged or even larger supply and the coke, no longer a saleable product, beginning to pile up in the stores. It is unfortunate indeed, but unalterable, that the technical necessities and economical demands do not always run parallel to each other.

The result of these considerations on the question of costing is that the point of view from which the calculation of costs is undertaken should also be altered ; since the other alternative, that of using the keying method and thus putting main and by-product on the same footing from the costing point of view is not recommendable, for the reasons already given. One is therefore forced to the decision that as long as the coke is the main product and the gas a by-product—a state of affairs which is probably considered as normal in iron and steel works—a charge price is given to the gas and the coke price calculated ; but if the situation is reversed, and the coke has to be stored because of insufficient demand, a charge price will be used for the coke and the gas price calculated. How the charge price of gas should be determined in the first place, has already been explained in the previous example. The charge price of coke in the second case is difficult

to find : it is the price that expresses the value of the coke to the works at the moment, when it is produced—to some extent against the desires of the management who are forced to do so by the demand for gas—or in the future, as soon as the economic situation has changed again and the stored coke has become saleable. From this last estimated price interest and storage costs should perhaps be subtracted to obtain the charge price. Of course there is some uncertainty contained in this price, but that is only natural with a storage price. The whole calculation of costs and results, however, now reveals a much more accurate picture of the situation, than would have been possible had the original viewpoint been adhered to regardless of the reversal of the relation between main and by-product. The gas costs will probably increase over those of the proceeds obtained, and losses will now be found on the gas production. If the gas is consumed within the works, the true costs of the gas and of the products made by the use of the gas, on whose account the coke ovens have been actually kept working, can now be found.

There is no question that the conversion of the roles of coke and gas as suggested above, will seem at first to be rather awkward to the production man ; but if he thinks a little more about it he will agree that it is the correct method and perhaps the only one to give figures as near to the truth as possible. In any case, no better method could be found for a fairly complicated plant with which the author had to deal about twenty years ago and which was at that time the object of somewhat heated discussions among all the people concerned. It was by no means a model plant built up according to a uniform plan, but as one meets so often in practice, it had grown up, been changed and modernised according to the improving knowledge and experience of a progressive management.

A central power station of a combined colliery and iron and steel works was originally equipped with a coal fired boiler-plant and steam engines. When it was learned that blast furnace gas could be used as fuel, large gas engines were installed and the boiler fires changed to gas, the steam engines being kept as a reserve. Subsequently the consumption of power increased considerably as the works had to deliver electricity to neighbouring towns and an enlargement of the power plant took place, using waste steam from the winding gear, pumps, etc., in an

accumulator and waste-steam turbines. When this equipment was working, it so happened that large fluctuations in the consumption of coal, iron and steel occurred: sometimes there was not enough gas and waste-steam for outsiders, and the municipal power stations had to provide electricity to the neighbouring towns, and even to some parts of the works.

As the costing system was based on the principle that each department should be considered as far as possible as a separate unit with its own monthly statement of production results, and as some departmental managers even had contracts including payment by results to some extent according to this statement, it will be clear that the mutual charge prices were a subject not only of great interest, but also of extreme difficulty for the accountant responsible. Unfortunately the files have been destroyed and the actual figures are no longer available, but it is certain that fair results would not have been obtained had the conversion principle not been used when necessary.

## D. DIRECT AND INDIRECT MAIN AND BY-PRODUCTS: COMPLEMENTARY PRODUCTS

These last examples, however, lead to still more important considerations. Hitherto only one main product and one or more by-products arising in the same course of production have been discussed. There are, sometimes, however, connections between two or more different production processes, mostly produced by one of the by-products, which can have the greatest influence on the economy of the whole works. Perhaps the most important example is the open-hearth process on the one hand and the coke oven and/or the blast furnace process on the other. One product, steel, creates the demand for another product, gas, which is the by-product either of the coke oven or of the blast furnace. The costs of the steel as well as of the coke and of the pig iron respectively can be correctly determined only if the gas is calculated at the right value, *i.e.*, at a price corresponding to the use which can be made of it for the time being. The less demand for coke and steel exists, the more expensive the product will be; it is therefore important to increase this demand, but it is doubtful whether a decrease in the price is always the best way to do it. If for example, 10,000 tons of coke could be sold at 12s. per ton, the total proceeds would be £6,000; but if 2,000

tons more were placed on the market, the price might go down to 10s. per ton and the total proceeds would again be £6,000. In other words, the additional 2,000 tons will have been given away. There is, however, another way of utilising by-products which cannot be sold, *i.e.*, consuming them in other departments of the works for the production of other goods. If in the above example the additional 2,000 tons could be utilised outside the works only by giving them away and a change in this situation could not be expected in the near future, other goods could perhaps be produced at saleable prices by means of this 2,000 tons provided that this 2,000 tons was put into the costs calculation with the value nil: this procedure would be quite justifiable in the given circumstances.

Another way of balancing the unequal demand for the main and the by-product of a certain production process is to find a substitute for the main product and thus limit its consumption.

Generally speaking, it is possible to distinguish between direct and indirect main and by-products, the former being that dealt with almost exclusively in the foregoing, *i.e.*, products arising from the same process; the latter the result of two different processes but connected by another product of one of these two processes. Thus, for example, the open hearth-steel the main product of the first process, produces a strong demand for gas, originally the by-product of the second process, the main product of which is the coke. This high demand for gas converts it to the direct main product and the coke to the direct by-product of the same process. The relation between the steel and the coke, however, is that of the indirect main product, steel, to the indirect by-product, coke, of two different processes. This new kind of connection leads to a new term, *i.e.*, that of "complementary products." These are products not produced in a common course of production, but connected with each other through the mutual possibilities of utilisation of their indirect by-products.

These considerations can be of the utmost importance to the economical success of the whole works, which can be obtained only if an almost complete utilisation of *all* products is guaranteed. Working to 100% capacity is of no use to the works if a part of the products cannot be sold at all, or only at such a low price

that the profitableness of the whole production is doubtful. The correct calculation has to show just how much the costs of the main products increase in such a case owing to the small value of the by-products ; very often the result will be a loss instead of the expected profit, a loss which effectively stops the intended expansion of the business.

In an iron and steel works, it is often Bessemer steel and open-hearth steel, which are the complementary products. It has already been shown how the demand for gas for the production of open-hearth steel can lead to over production of coke. This coke, however, can be used, if a higher demand for Bessemer steel can be obtained. Simultaneously, the increased output of the blast furnaces will increase the production of blast furnace gas and this will diminish the demand for coke oven gas : *i.e.*, Bessemer steel by consuming its indirect by-product coke, is a complementary product of open-hearth steel, diminishing at the same time the demand for the main product, coke oven gas, by producing blast furnace gas as a substitute. The question is : how can such a case be calculated ? The cardinal point is the value of the superfluous coke : if the coke can be sold at 10s. per ton on the spot without disturbing the market, the value of the coke oven gas can be calculated as follows :—

| | |
|---|---|
| 1 ton coal for coke production may cost | 12s. 0d. |
| Proportional production costs minus proceeds for by-products with the exception of coke ... ... ... ... ... | 1s. 0d. |
| Total ... | 13s. 0d. |
| Credit for $\frac{3}{4}$ ton coke (10s. ton) ... ... | 7s. 6d. |
| About 150,000 B.Th.U gas cost ... ... | 5s. 6d. |

The coke could be used at a price of 10s. per ton in the blast furnace. It is here assumed that the blast furnace gas can be substituted for coke oven gas without technical difficulties, and that in consequence 150,000 B.Th.U. of the former can be priced also at 5s. 6d. The costs of the pig iron could then be calculated thus :—

| | £ s. d. | £ s. d. |
|---|---|---|
| Burden ... ... ... ... | 1 15 0 | |
| 18 cwts. coke at 10s./ton ... | 9 0 | |
| Production costs ... ... ... | 10 0 | |
| Total ... ... ... | 2 14 0 | 2 14 0 |
| 150,000 B Th U. blast furnace gas | 5 6 | |
| Minus costs of gas cleaning ... | 3·6 | |
| Difference ... ... | 5 2·4 | |
| 450,000 B.Th.U. blast furnace gas uncleaned ... ... ... | | 15 7·2 |
| Costs of pig iron per ton ... | | 1 18 4·8 |

The usual calculation with a much higher value for the coke as main product and consequently a considerably less value of the blast furnace gas as by-product would have given a higher price for the pig iron, say £2 16s. 0d., and then perhaps the situation would have been considered uneconomical and corresponding conclusions would have been drawn.

Obviously the coke can be priced at the low value of 10s. per ton only in so far as it is on hand at this price. The calculation cannot be used for determining the average monthly price, as the whole of the coke produced cannot be utilised under the working conditions as explained. Generally the situation is as follows: provided that $a$ units of gas were produced giving $b$ units of coke, which can be used in the usual way, the profit would be the total proceeds of ($a$ units of gas plus $b$ units of coke) minus total costs. Now, assume that 100 tons more open-hearth steel are produced per month; for that $x$ additional units of gas are necessary, which means of course an additional production of coke of say $y$ units. Then the following questions must be answered: (1) What is the value of the $y$ units of coke? (2) What are the costs of the $x$ units of gas, and therefore of the additional 100 tons of open-hearth steel? (3) What are the costs and proceeds of the quantity of Bessemer steel, which can be produced by means of $y$ units of coke? (4) What is the result of the comparison between the extra costs and extra proceeds as obtained from the replies to (2) and (3)?

The answer to (4) decides whether the business in question is profitable, indifferent or involves a loss, but this answer could not be obtained by comparing the total quantities of $(a + x)$ gas, of $(b + y)$ coke, of the whole make of open-hearth steel and the whole Bessemer steel production; the actual circumstances would not be reflected in these average figures. The calculations discussed can be applied only in the case of additional production and only proportional costs should therefore be taken into account.

It should, however, not be forgotten, that this kind of calculation does not give a clear answer about the profitableness of a single product, but only of the two complementary products together: if the proceeds of both together are higher than the total costs, the order in question should be accepted, notwithstanding whether a loss for one of the products results or not.

There is also another method of calculation: if the price of Bessemer steel is known, it can be taken as a basis. Then the value of the coke can be determined by subtracting all other costs from the proceeds of the Bessemer steel. This coke value is higher than 10s. per ton, if according to question (3), the proceeds of the Bessemer steel exceeds the costs. By using this value for the calculation of the gas price the costs of the gas and of the Bessemer steel would be lower. The whole profit is now credited to the open-hearth steel while costs and returns are equal for the Bessemer steel. This is a complete parallel to the calculation of the direct main and by-products; *i.e.*, with the complementary products likewise the costs of the one product only are determined, the returns of the other product being credited to the total costs. The two methods of calculation bring about different costs and results for the individual products, but of course the same total result. In other words: with the complementary products as well as the direct main and by-pro- products it is not possible to determine precisely the costs of the single products.

As important as the knowledge of these connections is for the daily decisions which the management may have to make when confronted with incoming orders, it should not be overlooked that these should only be calculations, carried out from case to case by somebody who is well aware of all these connections and possesses a full survey of the market as well as the working

conditions in the works. The form of the routine work in the costing department, the current monthly survey, etc., should not be influenced by these considerations, as it would be dangerous to change the methods of work too often and too suddenly in a fairly complicated organisation composed mainly of subordinate persons accustomed to work according to rules fixed once and for all. But the knowledge of the connections between the direct main and by-products and complementary products respectively as explained above can be reflected and utilised when fixing the charge prices of by-products, which could be continuously controlled and changed monthly, if necessary, without disturbing the routine work of the costing department organisation.

With this the discussion of the by-product problem may be brought to an end, although there is no doubt that it is not treated exhaustively and that perhaps some readers may put it aside with the impression that it leaves them to depend in practice on their own consideration and decision. That, however, is nothing which should in any way surprise the practical man. Life generally and economical life in particular has so many facets that it will never be possible to catalogue all the possibilities. For centuries past all cases of law have been registered and so form a guide in jurisdiction, but every judge knows that he will never find a case so like a former one that he could simply copy the decision.

# PART III

# JOB ACCOUNTS

REFERRING to Fig. 1, it will be remembered that "accountancy" and "works accounts" are based on time while "job accounts" deal with the output expressed in quantity.

Disregarding for the moment that an order may be started shortly before the end of a month, so that it is worked partly in the previous month, partly in that under consideration, and that this may be repeated similarly at the end of the month, it can be said that the total result of the month can either be determined by accountancy in the manner previously explained, or by adding the results of all orders carried out during this month and expressed by job accounts. The overlap at the beginning and end of the month can be taken into consideration by certain corrections which will be of the more importance the more time the completion of an order takes on the average. As in an iron and steel works the majority of the orders is of a short term nature this correction will be comparatively unimportant. Be that as it may: the connection between accountancy and job accounts is obvious. The result of the summation of job accounts during a month can be considered as correct only if it is equal to that obtained by accountancy for the same month. This equality does not need to be correct to a penny; it is sufficient if the difference between the two results does not exceed, say, 1% of the total amount. This last remark is not superfluous because it is obvious. The author well remembers an ardent and certainly conscientious cost accountant in a works with about 3,500 workmen who worked for days to bring about this exact agreement till it was explained that the difference of methods in the two branches of industrial accounts made it nearly impossible to obtain precisely equal figures.

The connecting link between accountancy and job accounts consists of what we have termed: "works accounts" which are based, like accountancy, on time, and apply a method similar to that used when calculating job accounts. It is possible, therefore, to develop certain equations for determining costs in industrial concerns based on the figures of works accounts and applicable to time as well as output: but we have to keep in mind the possibility that the different purposes may require different procedures and even different figures, in which case care must be taken to balance the differences before a comparison is possible.

CHAPTER XII

# GENERAL EQUATIONS OF COSTS IN IRON AND STEEL WORKS

GENERAL equations for determining costs in industrial concerns may read as follows :—

*Direct material costs, i.e.*, costs of the raw material contained in the finished products minus any credit for scrap recovered.

+ *Indirect material costs* arising from storage and transport in stores, between stores and workshops and within the area of the works generally.

= *Total material costs.*

+ *Direct labour costs, i.e.*, direct wages paid in the final cost positions concerned.

+ *Indirect labour costs, i.e.*, expenses incurred by the workshops and the works administration, and allocated to the final cost positions concerned.

= *Total labour costs.*

+ *Special direct costs, i.e.*, costs arising for the particular order which can be anticipated with sufficient accuracy.

(Although these special direct costs are composed of the same types of costs as the usual costs it is considered expedient to deal with them separately in order to facilitate comparison with other orders. They are calculated as supplementary orders and then inserted into the main order.)

Then :—

Total material costs + total labour costs + special direct costs = *total production costs.*

To these total production costs must be added the costs of *selling and distribution*, which again may be divided into direct and indirect selling and distribution costs, the latter occurring

through the purchase of materials, accessories, etc., and in that part of the administration which concerns the trade or commercial side of the concern.

Finally :—

The production costs + the selling and distribution costs give the *complete total costs.*

How far can these general equations of costs be used in iron and steel works and, if necessary, be adapted to the particular conditions ? It has already been explained, that in these works class costing and order costing are the main forms of costing and careful consideration shows that the general equations can be used almost unchanged in both cases. It only remains to determine what relation the indirect or general costs should bear to the corresponding direct or composed costs, to enable the correct share of the indirect costs for any particular job to be calculated.

It is usual to relate the indirect material costs to the direct material by using the weight of the latter as a denominator. This cannot be considered as completely correct ; but it is usually considered as sufficiently accurate although it must of course be granted that it is and remains an approximation. This fact is used sometimes as a reason for putting the indirect material and the indirect labour costs together into one sum and relating the result to the direct labour costs, but this kind of calculation cannot be recommended ; the simplification is only slight and that the error which is contained in it should not be neglected, will be apparent as soon as some job has to be calculated where direct labour costs are nil as, for example, when delivering raw material from stores to customers without any further production processes. In this case the share of the indirect costs, according to the simplified calculations would be equal to nil, whereas it is obvious that storage and transport costs, etc., have arisen. Generally one can say that the fact that a special kind of calculation is only an approximation, does not justify choosing a much rougher approximation unless there are great advantages of another kind, *e.g.*, simplification, etc., counterbalancing the loss of accuracy.

Indirect labour costs are related to direct labour costs, and attention has already been drawn to the fact that either the direct costs themselves may be used as denominator thus arriving at

a percentage addition as an equivalent for the share of indirect costs, or the working hours of the men may be used, thus obtaining a figure of costs per working hour.

The indirect selling and distribution costs can be related either to the direct selling and distribution costs or—what is so usual that one may even say it is the rule—can be expressed as a percentage of the production costs.

These general explanations may be illustrated by a numerical example :—

| | Quantity tons | Price per ton £ s. d. | Value £ | Value £ |
|---|---|---|---|---|
| Cost of the charge .. .. .. | 12,000 | 4 0 0 | 48,000 | |
| + Supplementary costs of the charge .. | | 6 | 300 | |
| | 12,000 | 4 0 6 | 48,300 | |
| − Credit for scrap .. .. .. | 1,500 | 2 0 0 | 3,000 | |
| − Credit for scale and slag .. .. | 500 | | 50 | |
| | 2,000 | | 3,050 | |
| = Total Material costs .. .. .. | 10,000 | | 45,250 | 45,250 |
| Cost position 1 .. .. .. | Hours | Price per hour | | |
| Direct costs .. .. .. | | | 5,000 | |
| Indirect costs .. .. .. | 2,000 | 6 17 0 | 13,700 | |
| + Cost position 2 | | | | |
| Direct costs .. .. .. | | | 12,500 | |
| Indirect costs .. .. .. | 4,000 | 4 19 9 | 19,950 | |
| + Cost position 3 | tons | Price per ton | | |
| Direct costs .. .. .. | | | — | |
| Indirect costs .. .. .. | 10,000 | 13 8·4 | 6,850 | |
| = Total labour costs .. .. .. | | | 58,000 | 58,000 |
| Material + labour costs .. .. | | | 103,250 | |
| Rate of rejects 2% of (material + labour costs) .. .. .. | | | 2,065 | 2,065 |
| Production costs .. .. .. | | | 105,315 | 105,315 |
| Direct selling and distribution costs | | | 3,900 | |
| + Indirect selling and distribution costs = 8% of production costs .. | | | 8,400 | |
| = Selling and distribution costs .. | | | 12,300 | 12,300 |
| TOTAL COSTS .. .. | | | | 117,615 |

This example contains a column to which particular attention must be drawn, *i.e.*, the price per unit. The question of valuation which is answered by this column is again one which shows with

special clearness, the character of cost accounting relative to the purpose for which the calculation has been devised.

One could say with slight exaggeration that different costs could, and should, be developed for each individual purpose. As examples may be mentioned: that the "book value" is the correct basis for all figures of accountancy, production statements, etc., that "market prices" should be taken when endeavouring to find an adequate sales price or the profit accruing from a given sales price, and that "standard prices," excluding as far as possible all outside influences and internal contingencies, would be preferred for production control, planning, etc. This, of course, is not allowable in practice: the clerical work would be so enormous, that the final result would no longer be considered economical; but it is nevertheless good to clear one's mind before deciding on the necessary compromise. Generally, this problem of different valuations for different purposes mainly concerns raw materials. Wages, salaries and many other expenses do not in most cases, need any conversion from one "price" to the other, as the differences are too small; consumable stores are mostly of no importance; perhaps only fuel and energy—the latter, if obtained from outside—should be taken into consideration besides the raw material. It is usual to choose as a basis the "book value," which has to be taken for accountancy purposes in any case and can be used in many other cases, and to convert the figures obtained where necessary in the sense indicated above.

Perhaps it is not superfluous to add that these considerations hold good only for comparatively quiet times with the usual small fluctuations of market prices. As soon, however, as periods of real inflation or deflation set in, different measures must be taken to follow the course of events as far as that is actually possible, but dealing with these problems is considered outside of the scope of this book.

Attention may further be drawn to the fact that some deviation from the ideas of devaluation pointed out in this section will be developed in the course of this book, but it was considered that understanding would be helped if the methods at present usual in industrial works were explained before more modern views were discussed.

How do the above general reflections influence evaluation procedure in practice? It is useful to consider separately con-

sumed material and stocked material on the one hand, and in the case of the consumed material the various sources where deliveries and services originate on the other hand. Thus distinction should be made between deliveries and services from preceding departments of the same works, from other works of the same combine and from outsiders.

## CHAPTER XIII

# EVALUATION OF MATERIAL

## A. EVALUATION OF MATERIAL CONSUMED

**1. Deliveries and Services from Preceding Departments of the same Works.** It is usual in iron and steel works to use the production costs for the evaluation of deliveries and services from one department to another in the same works. Our English authority, the "Uniform Cost System" of the British Iron and Steel Federation states categorically under the heading Internal Transfers,[1] "The value at which productive and semi-finished materials are to be transferred from one process to another shall be based on *manufacturing cost*, and shall not include selling or administrative expenses or profit margins." The corresponding German source does not go quite so far: it includes in this transfer price administrative costs in so far as they are considered as part of the production costs, but strongly recommends for the iron and steel works proper, *i.e.*, the production from pig iron to rolled products, the "pure costs" without any profit margins. It explains that the determination of the individual results of a department with charge prices based on production costs and including a profit, is impossible; only fixed charge prices or market prices could be used for this purpose. This procedure would, however, have the disadvantage that the total profit on finished goods could be found only by a special calculation, *i.e.*, addition of the individual profits in the various departments concerned, and, where market prices were used, the actual result would be veiled by their fluctuations in consequence of outside influences. There would also be some intermediate products for which no market prices existed and a fictitious price would have to be chosen.

But it is significant of the uncertainty which the authors of this

[1] l.c., p. 13.

German source must have felt that they followed immediately with two important exceptions, wherein they recommend exactly the opposite, *i.e.*, what they have just condemned. This may be justified to a certain extent in considering the problem of main and by-products which has been sufficiently dealt with already and is mentioned here only for reasons of completeness. For the coupled main and by-products are, as we have seen, really products of a type differing from the usual products of iron and steel works, through the close connection between the main and the by-product. But is there also such an excuse for the products of the departments working up the steel to finished goods such as pressings made from plate, forgings, sleepers, springs, wire, etc.? This is how this exception is justified. " Even within the individual works there are some products where it seems to be unsuitable to use the production costs of the preliminary department as a transfer price. The limit for this procedure is given when the positive and organic course of production in the works has been finished. Then a refinement of the products begins, which is not generally usual at similar works. These departments are frequently in competition with free undertakings which do not produce the raw material themselves, but have to buy it at its market price. Therefore it seems to be expedient in principle to supply such departments at market prices, even if they are connected financially and locally with the supplying works. Thus they cannot become competitors of the free undertakings on an unequal basis." As these deductions are logical by themselves, it is not easy to see why they should not be applied to the departments of the iron and steel works proper, where it sometimes happens that the intermediate products such as pig iron, ingots or billets, are sold partly as finished goods to outside customers. The fact that " the positive and organic course of production " has not been finished is no reason for sticking to a method of costing if there are reasonable motives for changing it. This is a practical matter and the method which seems to be most suitable should be used; trying afterwards to find a logical connection between this decision and the course of the technological process seems to be unnecessary and perplexing.

The question is only, is the almost universal custom in iron and steel works of transferring material from one department to another at prices based on production costs without any profit

margin, the only suitable one and does it fulfil all requirements for which one may reasonably ask ? The author has known one of the big electricity combines fairly well and has himself worked for years for a large concern in the metal working industry where another system has been applied with great success, *i.e.*, fixed charge prices based on standard calculations of production costs and including a fair profit margin, as long as the standard working conditions on which the calculations were based were maintained, the general manager having the right of correcting these prices as often as he thought necessary. The author does not wish to be misunderstood : This system is not recommended for every case, but it has worked very well in the two cases mentioned above and as there seems no fundamental difference between these two concerns and iron and steel works, it is not evident why only the system now in general use should be recommended, especially as it sometimes has disadvantages which outweigh what is rightly regarded as its great advantages—simplicity and clearness. The main disadvantage is that it shows a profit only in the last, the "'final " department through which the finished product has to go when manufactured. Thus to all appearances the production of steel bars gives no profit to the blast furnace, the open-hearth melting shop and the billet mill ; this profit appears only in the production statement of the bar mill. Of course everyone in the management and in the works knows that this is wrong—if he meditates on it, but unfortunately he very often does not do it and the psychological result is often distressing. There are many who will not concede that this is a reason for a change in costing methods. They may keep to the system they are accustomed to, but experience as an employee in industry has taught the author to attach more and more importance to these " imponderabilia " and he is inclined to-day to render the work of the costing department more difficult by asking for some conversions, etc., if this is a means of giving greater satisfaction to the more ambitious people in the works. It is true that a second difficulty arises if the method of charge prices with a profit margin is adopted, as the amount of this margin rests more or less with the general manager, but this disadvantage can be converted into an asset since the decision on the charge prices gives him an opportunity to show his understanding and impartiality and thus increases his authority among his staff.

**2. Deliveries from other Works in the same Combine.** The best method of valuation for deliveries from other works of the same combine is certainly the use of the same prices which would be charged to outsiders of similar importance, *i.e.*, of market prices. Of course, the profits included in the prices of the delivering works are not real profits from the point of view of the combine as a whole as they are counter-balanced by the higher expenses of the receiving works. This should be taken into account when valuing the stocks in the receiving works.

There may, however, be reasons arising from the business conditions in the delivering works which seem to warrant a deviation from the use of market prices. Perhaps the delivering works are so much in need of work that they are willing to undertake the job in question at a greatly reduced price, without profit or even at a loss, as the order may cover at least a part of the fixed general costs. But even in this case the use of the market price for the internal settlement between the two works would be justified, for there is no reason why the receiving works should benefit from the other's difficulties. On the other hand it may be that these conditions should be taken into account when there are several works which could deliver the goods required to another works in the same combine, and the question arises which of them should be chosen.

Discussion of the use of other prices, for example, production costs without profit margin, or fixed charge prices, is omitted, although both methods are in use in some cases. The reader who has followed the earlier considerations about deliveries between departments of the same works, will understand without further explanation why the writer is not in favour of such methods.

**3. Deliveries from Outside Sources.** For deliveries from outside sources three different prices have also been recommended ; fixed charge prices, market prices and, what are sometimes termed, cost prices, *i.e.*, the prices which have been paid for the supply of the materials to the works. A fourth price, based on the estimation of the costs which would arise when the material in question has to be bought anew after consumption is of no importance in normal times and cannot be recommended as it is always subject to the uncertainty connected with estimation, but it plays a big role in times of inflation. Fixed charge prices

have the advantage that fluctuations in market prices are eliminated from the material accounts. If the finished products of the works are also calculated to fixed charge prices, the limits of the production are standardised and any changes in the production costs can be justly attributed to production changes alone. In spite of this undeniable advantage, fixed charge prices are not found very often in practice, probably because they may easily diverge too far from the actual prices.

The usual practice is to use the cost price which is almost identical with the "book value." There is no objection against this method as long as the cost prices and market prices do not differ too greatly. When, however, that is the case, it is good practice to take account of the differences—at least for the materials where they are of special importance such as scrap, zinc, tin, copper, etc.—with the help of special accounts of value corrections, in which losses and profits produced by the fluctuations of the market can be booked against the quantity consumed and the balance will show the necessary correction of the result obtained by use of the cost prices.

For the rest it may be sufficient to say that the evaluation at cost price or book value will not cause any difficulties if the rules which have been laid down previously in regard to stock accounts and result accounts are observed.

## B. EVALUATION OF MATERIAL STOCKED

It should not really be necessary to discuss separately the valuation of stocks, for stocks arise if deliveries have not been consumed completely, and it should be obvious that if deliveries to and issues from a stock account have always been made at cost price or book value, the balance, *i.e.*, the stocks, will remain on the account at cost price or book value likewise. Unfortunately this simple relation is sometimes upset by measures arising from the prudence of those responsible for the economic control and success of an industrial concern. Stocks which are in the works at the time of the yearly stocktaking should not be valued at a price higher than the cost price in the case of material bought from outside, or the production costs, in the case of semi-finished or finished goods produced in the works itself. If there is a market price and this is lower at the time of the stocktaking than the cost

price or the production price respectively, this lower price should be taken for valuing the stocks. This is the upper limit, but if it is considered suitable to choose an even lower price, it depends entirely on the opinion of the person responsible to do so, and use of this possibility is very often made in practice. Even in the course of the business year it may be desired to devalue the stocks in the same manner.

The best and least disturbing measure to adopt in such cases is to calculate the amount of devaluation necessary on a special account and debit it to the account as a whole, although the rule that a loss should not be shown on a stock account, but only on a result account, is violated by such a procedure. Of course, care must be taken that the price of the materials on the account is simultaneously changed and the new price used for issues from the account in future.

That may be sufficient to give an idea of the importance of the valuation problem, although many details have not been discussed rendering the carrying out of these measures in practice more difficult than may be apparent from the short description here given.

Here only one supplementary remark need be added. It is recommended that uniform stock prices should be fixed for all products which are stocked at several works of the combine simultaneously. Thus a uniform valuation of the stocks is obtained, double work is avoided, comparison of the stocks of the various works is easier and the drawing up of the total balance of the combine is facilitated. The disadvantage is that differences appear between the production costs or fixed charge prices of the individual works—whatever may be used as stock prices—and the uniform stock prices. This may necessitate stock revaluations of the semi-finished and finished products. This difficulty is not of importance for materials and goods delivered from outside, as they are mostly supplied according to an agreement settled by the common purchasing department of the combine, and the price differences are not large even with individual purchasing.

## C. CONNECTION BETWEEN THE EVALUATION OF CONSUMED AND STOCKED MATERIALS AND GOODS

As should be clear from the previous explanations, there are differences in the valuation of consumed and stocked material and goods which must, of course, be eliminated before the comparison of the accountancy results and job accounts is possible. It has already been said that this is best carried out by means of a revaluation account ; but it seems to be worth while to discuss the question somewhat more in detail, especially as it has been recommended that stock prices should be used not only at the end of the business year, but also during the year for the monthly statements of results. Whether to follow this advice or not may be left to the individual. The advantages and disadvantages of both methods are fairly balanced.

These revaluations refer mainly to deliveries from other works of the same combine and to semi-finished and finished goods of the works production. They are almost out of the question for supplies from outside sources because here there is no reason for a different valuation of consumed and stocked materials ; diminution in the value of the latter, however, by inclusion of reserves should be omitted in the interest of clarity and truth in the balance sheet.

How this revaluation of an account of semi-finished or finished products can be carried out is illustrated by the following example :

STEEL BAR-STOCK ACCOUNT

| Dr. | Tons | £ s. d./ton | £ | | Tons | £ s. d/ton | Cr. £ |
|---|---|---|---|---|---|---|---|
| 1.1 Stock .. .. | 800 | 4 15 0 | 3,800 | 31.1 to Production account .. | 1,500 | 6 0 0 | 9,000 |
| 31.1 Production .. | 2,100 | 6 0 0 | 12,600 | 31.1 Balance .. .. | 1,400 | 4 15 0 | 6,650 |
| | | | | Revaluation .. .. | | | 750 |
| | 2,900 | | 16,400 | | 2,900 | | 16,400 |
| 1.2 Carried forward | 1,400 | 4 15 0 | 6,650 | | | | |
| 28.2 Production .. | 1,900 | 6 4 0 | 11,780 | 28.2 to Production account .. | 2,300 | 6 4 0 | 14,260 |
| Revaluation .. | | | 580 | 28.2 Balance .. .. | 1,000 | 4 15 0 | 4,750 |
| | 3,300 | | 19,010 | | 3,300 | | 19,010 |
| 1.3 Carried forward | 1,000 | 4 15 0 | 4,750 | | | | |
| 31.3 Production .. | 2,200 | 6 1 0 | 13,310 | 31.3 to Production account .. | 2,400 | 6 1 0 | 14,520 |
| Revaluation .. | | | 260 | 31.3 Balance .. .. | 800 | 4 15 0 | 3,800 |
| | 3,200 | | 18,320 | | 3,200 | | 18,320 |

The stock at the beginning and end of the three months was equal, *i.e.*, 800 tons; but the revaluations gave a difference of 580 + 260 − 750 = £90 owing to the difference in the production costs in the three months.

CHAPTER XIV

# STATEMENTS OF PRODUCTION AND SALES RESULTS

## A. PRELIMINARY REMARKS

ACCOUNTANCY through the balance sheet and the profit and loss account provides the final results of the production and sales of any possible period, and if not otherwise stated it is usually taken for granted that the financial year of the concern in question is the basis of the figures. There can, however, be no doubt that an accountancy built up according to the principles laid down in this book will allow of closing figures for shorter periods—a month or even a week—being obtained. It rests completely with the responsible accountant how far he will go into detail in these short-term statements or what simplification he wants to use compared with the yearly balance sheet and profit and loss account. The once much discussed problem of these short-term statements can be considered solved in principle by these few sentences, although it is well understood that difficulties may arise to make the work much more complicated than it would appear from the above remarks

That, however, is not the object of the present considerations ; attention should rather be drawn to the fact that the usual balance sheet and profit and loss account gives the final results of production and sale either only summarily or analysed from one point of view only, *i.e.*, that of the accounts or types of costs. The management, however, is greatly interested also in the other viewpoints, *i.e.*, of departments and cost positions or of bearers of costs as expressed by orders from customers or other sources, these orders being perhaps collected into groups according to their financial importance, their nationality or the districts of the various agents or representatives of the delivering concern, etc. These analyses are shown by special statistics, which may be called " statements of production and sale results " or more shortly " production and sale statements."

As may be understood from these explanations, there is a close connection between these statements and the profit and loss account, and care must be taken that no discrepancies arise between them or that, if that should be the case, these are cleared up or removed. But it may again be pointed out that under the term "discrepancies" only considerable differences are meant since small differences can scarcely be avoided in comparing figures compiled by different methods. The figures of accountancy can usually be considered as correct as they, collected by book-keeping by double entry, are already very strictly controlled arithmetically.

Further, it is obvious that there may be many schedules for building up such production and sale statements and that the management has to decide which way would best suit the concern in question. In such cases it is nearly always impossible to develop general rules apart from common phrases which are of no use to the practical man. It is better to show him how other people in the same industry have answered this question and let him form his own opinion on this before deciding. Such an example may again be taken from the German source thus giving the English specialist the possibility of simultaneous comparison.

When considering this example, the reader should bear in mind that the transfer of material and goods from one department to another in the course of production has been done at production costs without any profit margin; for otherwise the procedure would certainly be different to some extent.

The production and sale statement given in the example is a comparison of the individual proceeds obtained for the goods dispatched in the month in question and of the production costs of *these* goods. The difference is termed the "dispatch result." The form in which this comparison is made is mostly that of an account with the proceeds on the one side, the production costs on the other, and with the dispatch result as balance. The arithmetical sum of the dispatch results of the individual items is the net result of the departments; it is, exactly as the dispatch results were, still divided into the individual items, but to this some items must be added which are kept on the books as one sum for the whole works, *e.g.*, the selling costs, amounts of revaluation of raw material stocks, and expenses and returns of a neutral character. Only then does the net result of the departments

develop into the net result of the works which appears in the profit and loss account given by accountancy.

## B. THE PROCEEDS SIDE

The amount of the invoice to the customer is the gross proceeds of the order in question. The sum of all such invoices against deliveries and services which make up the purpose proper of the concern is the gross turnover. The sale of parts of the plant itself, Stock Exchange business, income from rents and leases, etc., are therefore not included in the gross turnover. The gross proceeds have to be diminished in most cases by some corrections unless these have already been taken into account when calculating the production costs, *e.g.*, purchase tax ; freight (if carriage paid delivery is agreed upon) ; transport insurance ; packaging costs ; customs dues ; agent's commission ; differences in price or weight; goods to be taken back (as far as they cannot be considered as rejects which will have been taken into account in the costs), etc. When these corrections are deducted from the gross proceeds the net proceeds result. The corrections can either be charged directly to the result accounts of the products or they can be collected on preliminary accounts and then be transferred as one posting to the corresponding result account. It is more or less a matter of taste which way is chosen, but the first is preferable in that it is similar to that used in estimating (for fixing or controlling the selling price), where most of these corrections are considered as a part of the costs.

It is usual to divide the proceeds into groups within the individual products according to the various kinds of orders and thus facilitate the analysis of the proceeds and results. How far such division should go can be decided in each case only according to the type and extent of the works. The following scheme has been recommended for iron and steel works with their many departments working partly parallel to each other, partly in series :—

Inland.
Export.
Consumption within the combine.
Further working up within the combine.
Consumption within the works.
Further working up within the works.

Inland orders are for concerns within Great Britain, for outside firms as well as allied trading companies. Orders are also included from undertakings in which the parent company is interested, with the exception of those which are completely in the possession of the head company, and which are therefore best considered as a part of the concern.

Under export are considered orders from companies outside Great Britain, including deliveries to the firm's trading companies abroad, and to companies in which the parent company is interested but does not control.

As examples of consumption within the combine may be mentioned :—

Deliveries to maintenance shops and rebuilding departments.

Moulds for melting shops.

Rolls for rolling mills.

Delivery of energy (electricity, steam, water, compressed air).

Delivery of fuel (coal, coke, gas).

Delivery of refractory bricks, tar, benzol.

As examples of deliveries for further working up within the combine may be considered :—

Ore, pig iron, steel ingots, semi-finished products, scrap from rolling or casting.

Rails for points.

Wheels for railway waggons.

Slag sand for cement plants.

Coking coal for coke ovens.

The terms " consumption " and " further working up within the works " may be understood analogously without further explanation, but it may be mentioned that deliveries for further working up within the works are not part of the work's turnover and for further working up within the combine, are not the turnover of the combine.

## C. THE COSTING SIDE

As already mentioned, the costing side of the production and sale statement, consists of the costs of the products, whose

proceeds have been booked on the other side. These costs can be either the actual production costs as already explained or "standard costs," a term which will be defined later in detail. Here it may be sufficient to say that standard costs are those which would appear under normal conditions in the works, *i.e.*, standard costs will generally be lower than those given above as actual production costs.

Furthermore a different procedure will be necessary according as the costs have been determined by order, class, or division-costing. In the first case the costs of the individual products are directly given by the costing system; in the second and third cases only the costs per unit may be given by the costing system and these have to be multiplied by the number of units of the individual products delivered during the month in question.

If now actual production costs are applied, they can be used directly for all products which are delivered *and* produced during the month under consideration and which have been booked to and from the stock account of the product concerned. If, however, products are sold originating from stock produced in former months at different actual production costs, an analogous procedure is, of course, easily applicable to products calculated by order costing, where the actual costs of the product in question can be credited to the stock account and debited to the result account; but with class and division costing it will be simpler to use for delivery from stock the costs of the month under consideration. The differences against the costs originally charged to the stock account in former months remain in the stock account and must be eliminated at the end of the month by a special booking, that brings about the balance between the stock account and the result account of the product concerned.

If standard production costs are applied they can be used equally for products produced during the months under consideration and for deliveries from stock accumulated in former months. The difference between proceeds and costs—termed "dispatch results" in the former case—however, will usually be greater in this second case, where it may be termed "business result"; for it contains that part of the fixed costs not covered by percentage additions corresponding to the normal turnover. (The opposite

case, where the business result is larger than the dispatch result, *i.e.*, where the actual fixed costs are over-covered, is possible, but very seldom happens ; it is here mentioned only for reason of completeness.) These differences are found when determining the costs of the individual cost positions. They may therefore be termed " revaluation of cost positions."

This revaluation is independent of the nature of the goods produced and could therefore be booked directly to the profit and loss account ; but if one wants a production result to show standard costs also, which is to a certain extent comparable to the dispatch result of the products calculated to actual costs, a supplementary allocation of these costs to the individual groups of products in the production and sale statement is necessary. This allocation may be carried out according to the key used when attributing the other general costs of the cost positions to the works orders or bearers of costs.

## D. COMPARISON OF BOTH SIDES

To the production result must be added the differences which, originating from the individual stock accounts, result from the different prices per unit for stock and for consumption. They may be credit or debit positions according as additions to or deliveries from the stores take place.

Subsequent changes of bookings concerning deliveries during previous months have to be taken into account, *e.g.*, changes of turnover by price reductions, discounts imposed by customers over the set terms, etc., or changes of costs due to retroactive changes of market prices or freights, etc. They can also be caused by some procedure within the company itself, when, for example, subsequent changes of expenses are considered necessary for depreciation, reserves for taxes, etc. The production result, thus amended and summarised, of all products of a department during the months in question, develops into the net departmental result, which can and should be verified by comparison with the result of the balance sheet and profit and loss account for the same period.

## E. CONNECTION BETWEEN PRODUCTION AND SALE STATEMENT ON THE ONE SIDE AND BALANCE SHEET AND PROFIT AND LOSS ACCOUNT ON THE OTHER SIDE

In order to make the production and sale statement agree with the balance sheet and profit and loss account, the net departmental results must be reduced by subtracting everything that has not been included either in the costs or the proceeds. Furthermore, the credits must be added for returns which have not been taken into account when determining the costs of the department.

This entails the following debits and credits :—

*Selling Costs.* The reader will remember that they have not been included in the actual production costs.

*Stand-still Costs.* Expenses for a department which has been brought to a standstill can be passed on to those departments which have taken over its production ; if, however, this production has been abandoned completely, they must be charged to the profit and loss account.

*Depreciation and Interest.* If there is a difference between the depreciation and interest as used for building up the costs on the one hand and as booked in accountancy on the other, the former must be either monthly or yearly (at the end of the financial year of the concern) considered as an income and the latter accordingly charged to the profit and loss accounts.

*Revaluations of Material.* As explained these are amounts which originate from the material stock accounts as the result of the difference between market or consumption price and stock price.

*Neutral Returns and Expenses.* These items also have been explained ; they refer to transactions which are not connected with the production proper of the concern, *e.g.*, revenue from leased lands, profit from Stock Exchange business, welfare foundations, etc.

Fig. 35 gives a summary of these considerations and Fig. 36 a numerical example of a production and sale statement for an individual product, *i.e.*, plates.

Gross proceeds
— corrections

net proceeds

Divided into :
Inland
Export
Consumption within the combine.
Further working up within the combine
Consumption within the works.
Further working up within the works.

Minus

Standard costs
= Business result
± Revaluation of cost position

Actual costs
= Dispatch result

PRODUCTION Result

± Revaluations of stocks.

± Changes of turnover and of costs of cost positions.

= NET DEPARTMENTAL RESULT

— Selling costs.

— Stand-still costs.

± Differences of depreciation and interests in accountancy and costing.

± Revaluations of material.

± Neutral returns and expenses.

= NET WORKS RESULTS (practically equal to the result of the profit and loss account).

FIG. 35. Development of the production and sale department.

STOCK

| | Quantity | Price/ton | Value |
|---|---|---|---|
| | tons | £ s. d. | £ |
| Stock at the first of the month .. .. | 1,200 | 5 0 0 | 6,000 |
| Production: Actual costs .. .. .. | 7,000 | 6 7 0 | 44,450 |
| Production: Standard costs .. .. .. | — | — | — |
| Total .. .. .. .. | 8,200 | | 50,450 |
| Dispatch .. .. .. .. .. | 7,500 | 6 4 0 | 46,500 |
| Revaluation of stocks .. .. .. | | | L[1]450 |
| Stock at the last day of the month .. | 700 | 5 0 0 | 3,500 |

*Continued on next page.*

[1] L. = loss (in the original documents written in red ink).

## SALE AND CONSUMPTION

| | Quantity | Gross proceeds/ton | | | Net proceeds/ton | | | Net turnover | Actual costs of the dispatch | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | tons | £ | s. | d. | £ | s. | d. | £ | £ | s. | d. | £ |
| Inland .. .. | 4,000 | 7 | 2 | 0 | 6 | 13 | 0 | 26,600 | 6 | 0 | 0 | 24,000 |
| Export .. .. | 2,000 | 6 | 19 | 0 | 6 | 5 | 0 | 12,500 | 6 | 16 | 0 | 13,600 |
| Consumption within the combine .. | 500 | 6 | 6 | 0 | 6 | 6 | 0 | 3,150 | 5 | 14 | 0 | 2,850 |
| Further working up within the combine | 800 | 6 | 15 | 0 | 6 | 14 | 0 | 5,360 | 6 | 1 | 0 | 4,840 |
| Consumption within the works .. .. | 100 | 6 | 12 | 0 | 6 | 12 | 0 | 660 | 6 | 0 | 0 | 600 |
| Further working up within the works .. | 100 | 5 | 18 | 0 | 5 | 18 | 0 | 590 | 5 | 10 | 0 | 550 |
| Total and average .. | 7,500 | 6 | 19 | 0 | 6 | 10 | 0 | 48,860 | 6 | 4 | 0 | 46,440 |

## PRODUCTION RESULT

| | Dispatch result. Business result | Revaluation of cost positions | Gross production result | Export charges[1] | Net production result |
|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ |
| Inland .. .. .. .. | 2,600 | — | 2,600 | L.1,000 | 1,600 |
| Export .. .. .. .. | L.1,100 | — | L.1,100 | L. 200 | L.1,300 |
| Consumption within the combine | 300 | — | 300 | L. 125 | 175 |
| Further working up within the combine .. .. .. | 520 | — | 520 | L. 200 | 320 |
| Consumption within the works | 60 | — | 60 | — | 60 |
| Further working up within the works .. .. .. .. | 40 | — | 40 | — | 40 |
| Total .. .. | 2,420 | — | 2,420 | L.1,525 | 895 |

## DEPARTMENTS RESULT

| | Month under consideration | Since beginning of the financial year | During the same period last year |
|---|---|---|---|
| | £ | £ | £ |
| Net production result .. .. .. | 895 | 6,600 | 9,000 |
| Stock revaluation .. .. .. .. | L. 450 | 1,050 | 1,700 |
| Turnover corrections .. .. .. | 200 | L. 600 | L. 800 |
| Costing corrections .. .. .. .. | — | L. 400 | L. 300 |
| Payment to/from federation[1] .. .. | | 1,400 | 950 |
| Net departments' result .. .. .. | 645 | 8,050 | 10,550 |

FIG. 36. Production and sale statement for plates—month July.

[1] In consequence of the regulations of the Employers' Federation.

## F. SOME CRITICAL REMARKS

When considering the example of a production and sale statement as illustrated by Figs. 35 and 36 it may be doubted whether an arrangement has not been developed here which is out of proportion to the final result and whether the work which has to be done is really paid for by the advantage drawn from the figures obtained. This, however, will be the object of later considerations when some important features of modern cost accounting which up till now could only be mentioned have been discussed more in detail, such as the influence of the degree of activity in the shops on the production costs, the idea and use of standard costs, etc.

The question may be asked, however, whether this example can really be considered a complete model as it is certainly intended to be. There is no doubt that anybody working strictly on the lines of this example, will finally come to a correct result, which may be helpful when confronted with new decisions whether this or that product should be more favoured in a future advertisement campaign, put more into the background, or even abandoned completely; but the longer the whole scheme is pondered over the more it becomes probable that there is a more simple way to arrive at the same or nearly the same and sufficiently accurate result. This impression is undoubtedly produced by the repeated positive or negative corrections necessary to bring about an agreement between the figures of accountancy and costing.

Thinking about these corrections, however, the reader will soon find out that they could be avoided, at least the majority of them, if the simple rules that have been given in the course of our explanations had been carefully observed. For instance, if the balance sheet and profit and loss account were developed with the primary object of finding "the truth, the whole truth and nothing but the truth" of the economic position of the concern in question, the figures for depreciation in accountancy would not differ from those used in costing; a correction of this item would be out of the question.

Revaluations of material, when necessary in exceptional cases, should be transferred immediately into the figures of accountancy in such a manner that a discrepancy between the branches of industrial accounts should be impossible from the start.

Differences between the prices of stock and of present consumption disappear almost completely, if the material accounts, divided into stock accounts and result accounts, are kept strictly by the rules previously developed. How revaluations of cost positions can be avoided or at least reduced to insignificance has been explained in detail when discussing the "work-in-production" account.

Above all, however, that impression of extreme complication which seems to be a fault of the example illustrated by Figs. 35 and 36 would disappear, at least to a large extent, if two things were taken into account, which have nothing to do with the essence of the subject, but only with the nature of the description.

First, one should not try to develop the production and sale statement independently from the balance sheet and profit and loss account. If it is sometimes believed that a new control of accuracy is thus obtained, this idea must be considered as absurd : for there is only one set of figures which are arranged in a different manner, and if then the same final result is obtained that is certainly no proof of correctness ; whereas the figures of accountancy have been booked by the double entry method, which is in itself a sufficient guarantee. It should rather be preferable to use the short-term balance sheet and profit and loss account as a basis, remove from them all figures, which obviously have nothing to do with the purpose proper of the concern in question—for example, " stand-still costs " and " neutral returns and expenses," which should be collected from the beginning on special accounts so as to be easily separated—and build up the remaining figures, analysed in balance sheet and profit and loss account according to types of costs, according to another principle, *i.e.*, the bearers of costs or orders. Even then some corrections will remain, *e.g.*, changes of turnover and of costs of cost positions ; but they will be rare and of little importance.

Secondly, one has to consider that the illustration of the example by Fig. 35 contains all possible corrections, additions and deductions, because it is intended to be a complete picture of everything that *might* possibly happen ; but it is very improbable that all these possibilities will actually accumulate in *one* case in practice.

A further, and according to the experience of the author,

considerable simplification could be obtained if fixed charge prices were introduced for transferring materials and semi-finished products from one department to the other; but a discussion of this problem may be omitted as further considerations in the next sections will reveal more and more the problematic nature of the production and sale statement of the usual form.

# PART IV

# STANDARD COSTS

CHAPTER XV

# THE INFLUENCE OF THE ACTIVITY FACTOR ON COSTS

THE general equations of costs as developed in Part III of this book are very often reduced to the form,

$$\text{Total costs} = \text{costs of material} + \text{wages} + \text{overheads},$$

where overheads are expressed as a percentage of wages. The terms "material" and "wages" are, of course, to be understood as abbreviation of the direct parts of these items. From this equation—together with the fact that, when in a shop the direct costs of material and wages decrease, the degree of activity diminishes, but the overheads do not decrease proportionally—it is clear that the percentage expressing the ratio $\frac{\text{overheads}}{\text{wages}}$, must increase. This explains why the costs of any product rise if the output diminishes. On the other hand, this decrease in activity very often indicates an economic depression, *i.e.*, the demand on the market is less than the supply, and the result is a fall in the prices. If, however, at the same time the costs of a product increase and its price drops, there is a danger that the margin between both—the profit—will diminish substantially or even become a loss.

These brief remarks have been made prior to the following, more detailed discussion of the problem in question, in order to illustrate its importance. As a matter of fact the more intimate study of the connections indicated in the heading of this section has completely changed the outlook of cost accountancy during the last 15 or 20 years, and has led to quite new developments and to a considerable simplification when applying these ideas in practice. It is true that these consequences have not yet been everywhere appreciated in their entirety, and it is the authors' hope that his explanations may give here or there an impetus in this direction.

## A. HOW CAN ACTIVITY BE MEASURED AND WHY ?

In order to characterise the activity in a shop or in a works, either an *absolute* figure can be used, *e.g.*, the melting shop has during May produced 2,800 tons, or a *relative* figure, the degree of activity, *i.e.*, the ratio of production expressed as an absolute figure to a certain standard production, which must be defined in each individual case. This ratio can be expressed either as a decimal fraction or, more usually, as a percentage. In both cases, *i.e.*, when using an absolute figure or a ratio, the measure used must be accurately stated and so must the moment or period to which the figures are related : without that they are of no use for economic purposes. Although this is so obvious these necessary additions are frequently forgotten. Each measurement of the degree of activity therefore always presumes the determination of an absolute figure of production capacity for the length of time in question, as will be discussed in detail later on.

The measurement of activity is necessary :—

(1) For production control, when, for example, the expenditure of shops in the same or different periods is to be compared with the rate of production ; when the profitableness of various procedures of various plants or of various departments is to be compared ; when planning and estimating (budgeting) the consumption of material, labour, plants, overheads, etc., while taking into consideration the various degrees of activity.

(2) For cost-calculation and price-fixing, when production costs or total costs must be determined for different degrees of activity according to their use in book-keeping, for valuation of semi-finished or finished goods, or for tender purposes.

(3) For internal or external statistics when the activity of a department is to be compared at different moments or for different periods ; when the activity of similar departments of the same works is to be compared at the same moment or for the same period ; when investigations of a politico-economic character are necessary, as, for instance, capacity and utilisation of existing plants for the production of war material.

As may be seen from this exhaustive enumeration there are many and very different purposes where the idea, "activity factor," *i.e.*, the figure representing the degree of activity, may be used and it is not astonishing in these circumstances that its special determination can change from case to case.

## B. THE ACTIVITY FACTOR IN AN INDUSTRIAL WORKS

It can be considered exceptional when the activity factor can be given for a works as a whole; generally speaking, its shops or departments have different factors at the same time. For example, it has already been pointed out that production and sales

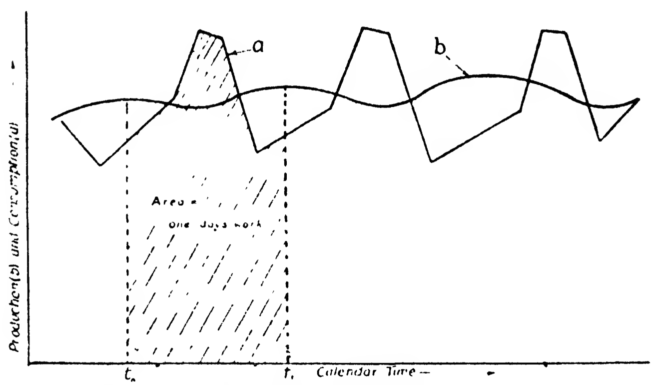



FIG. 37. Production and consumption of gas.

and distribution are independent of each other to a large extent. It is therefore not surprising that the curves in Fig. 37 showing (*a*) the consumption of the products of a gas works and (*b*) the rate of the production, differ considerably at the same moment. Only taken over a period of a day between $t_0$ and $t_1$ are they nearly equal, the fluctuations balanced by means of the gasometer. Similarly, at a rolling mill differences may occur between produced and dispatched material, even if more irregularly, and the fluctuations are equalised in this case by means of the stocked material. The curves *a* and *b* in Fig. 37 show, therefore, only the "activities" of the production and consumption respectively. It will be the rule in iron and steel works that they are equal only when the average is taken over a more or less extended period. Exceptions are the electric power station, the maintenance and

the traffic departments. Sometimes even a department cannot be considered sufficiently uniform to give one rate of activity, and it may be necessary to go into the working conditions of the individual cost positions. It must be left to the decision of the responsible man, how far to go in an individual case; it is quite impossible to give more than these general hints. There is also another point of view which should be kept in mind when determining the activity factor. This figure can be greatly influenced by "internal orders," for maintenance, for stock, and generally speaking by measures taken by the management for their own reasons, but which must be excluded, together with their consequences, if the activity resulting from the condition of the market is the vital factor in the decision.

Of the external orders only those which have already been taken into production are of influence when determining the degree of activity of production. One finds sometimes that the orders on the books are considered as a correct expression of the momentary situation; it will be understood that that is not quite correct. The difference may not be considerable in iron and steel works, where orders will usually be executed a few days after receipt; but enough cases are known where that was impossible, especially in times of emergency. Neglect of this consideration may then lead to very unpleasant mistakes.

Finally, attention may be drawn to the fact that the activity of one and the same shop or department at different times, even when applying the same measure of activity, cannot always be compared; a further supposition is that no important change of the procedure of work, of the plant, or of the organisation has taken place in the meantime. If, for instance, the measure is in both cases the number of "productive" working hours and the plant has been mechanised in the meantime to a larger extent, it may easily happen that the calculated activity factor has dropped to 60%, while the activity measured by the output figure has even been increased, or at least kept at the old level.

## C. THE MEASURES OF ACTIVITY

There are innumerable measures which could be used for measuring the activity of a department or works, but in the long run they are nearly always based on or connected in some way with the quantity of work consumed or produced in a certain

period. This quantity, however, is always the product of the intensity of utilisation of the individual workplaces or machines or plants and of the time of this utilisation, *i.e.*, it is equal to the area in Fig. 37 bounded by one of the curves, the abscissa and the two ordinates indicating the period concerned.

The time of utilisation may be the full calendar time, as, for instance, in the case of the engines at a public electricity works; it may be one, two or three shifts of 8 hours, during 25 days per month. *i.e.*, apart from the pauses for rest, a shift time of 600, 400 or 200 hours per month, etc. In any case, it is easy in each individual case to determine the time of utilisation accurately enough for practical purposes. That, however, is unfortunately not so with the intensity of utilisation. It is very exceptional when the course of this intensity can be represented by a curve like those in Fig. 37 as for instance, the load of an electricity works in kW. Usually, measures must be used which show the intensity of utilisation only approximately and under certain assumptions, which may be but are not always right: as, for example, if it is stated that 200 men were occupied in this department at the beginning of the month, but this number went down gradually during the course of the month to 150, and the number of men is then taken as the measure of the intensity of utilisation of the department. Here, it is supposed that the quality of working of the men is and remains equal, but there is no production engineer who does not know that that is incorrect. Other approximate measures are quantities of production per unit of time, as cubic ft./min. for gas or tons/hour for rolled steel, etc., or the same items but expressed in money, either as expenses or as proceeds. The weak spots in these measures are obvious, and the change-over to the money measure makes the situation still more doubtful.

The measuring of the activity by the quantities produced can lead to wrong results, if the semi-finished products within the department are not the same, either in quantity or with regard to the state of production, at the beginning and at the end of the period taken into consideration; similar difficulties arise when using the output as a measure of the activity of the whole works.

Men-hours or machine-hours (*e.g.*, rolling hours in a rolling mill) are often used as the measure of activity for production departments. They are simple and contain comparatively few sources of

error. Besides, they are a product of both measures ; time of work and intensity of work. For example, 5,000 men-hours can mean that 25 men have worked 200 hours shift time ; but here also a tacit supposition has been made, *i.e.*, that the load on the individual machines or the intensity of work of the individual men is the same, and that will always be the case only approximately.

Thus it must be stated generally that—apart from very simple cases of mass-production—all measures of activity should be considered with reserve and conclusions based on them should always be taken as only relatively correct. It may, therefore, be recommended to use two or three of these measures, one beside the other, in cases where it is of special importance to obtain a safe basis of judgment. Thus, one finds, for example, in general business reports or in prospectuses when applying for the admission of shares as marketable stocks, the production activity given simultaneously as an average of that of the individual departments and the total output and the total customers' orders received, these last two items expressed in quantities as well as in money, etc.

## D. RATE OF LOAD AND RATE OF TIME UTILISATION

If a colliery produces 80,000 tons per month, it is possible that this result is obtained perhaps

in 25 days of 3,200 tons per day,
in 22 days of 3,635 tons per day or
in 20 days of 4,000 tons per day.

In such cases it is not sufficient to know the one figure of activity ; there also should be stated the load and the time of the load, the activity being the product of both, in the example, for instance, 80,000 tons = 25 × 3,200 tons. Just as a rate of activity has been developed from the figure of the activity the terms " rate of load " and " rate of time utilisation " can be applied, the relations between these items being :—

$$\text{activity factor} = \frac{\text{actual activity}}{\text{standard activity}} =$$

$$\text{rate of load} \times \text{rate of time-utilisation} =$$

$$\frac{\text{actual load}}{\text{standard load}} \times \frac{\text{actual time}}{\text{standard time}}$$

The term "standard" is used in this connection in order to indicate what may be considered as the basis of comparison.

How should these bases of comparison be selected ? The upper limit of *time-utilisation* is given by the calendar time. As the length of years (leap year) and months is not constant, sometimes this upper limit is fixed uniformly at $365 \times 24 = 8{,}760$ hours per year and $8{,}760/12 = 730$ hours per month, for example, in public electricity works, and this can be recommended also for industrial undertakings. This time may be termed the "maximum load time."

All other standard times depend on regulations made either by the works management or contained in agreements with the trade unions or ordered by the Government. Based on these regulations a "planned load time" can be calculated during which the works should work as a rule and according to their whole layout and plant.

Usual planned load times are :—

(1) The calendar time, if the works or departments in question are working continuously and a reserve plant in working order is at hand.

(2) The calendar time minus periods for overhaul, in special cases of continuous working of a single part of a plant which needs more or less regularly stoppages for maintenance, etc., *e.g.*, day- and night-work of a low temperature carbonisation retort the lining of which must be replaced from time to time owing to the effect of heat.

(3) The calendar time minus legal holidays, all workdays being planned as three shifts of 8 hours each. In this case an average calculation is often used of

$$300 \text{ days} \times 24 \text{ hours} = 7{,}200 \text{ hours per year, or}$$
$$25 \text{ days} \times 24 \text{ hours} = 600 \text{ hours per month.}$$

(4) As under (3), but each day with one shift of 8 hours, *i.e.*, average calculation, 2,400 hours per year or 200 hours per month.

When fixing the basis of comparison for the *load* the following circumstances should be taken into account :—

(*a*) Each part of a plant and each working place has a nominal or continuous output or production ; that is the load which can be put on the plant at least for the duration of the planned load

time without interruption. (It should not be overlooked that the maximum load is different from this nominal or continuous load, not only in quantity but also in character as the quantity of the maximum load depends largely on the duration of the overloading, whilst the nominal or contnuous load is a fixed item for each part of the plant.)

(*b*) It is possible in a department to harmonise all parts of the plant and the working places in such a manner that they are working up to the limit of their nominal load when producing a certain quantity and type of products. In such a case it is, however, probable that for another type and quantity of production only some parts of the plant are working with nominal load, but the others less; for the complete harmonisation of the plant for *all* possible kinds of production could not be attained for technical or economic reasons. This is, for example, nearly always the case in a rolling mill plant with a largely varying rolling programme, where the question of "bottlenecks" can be considered as the *bête noire* of the production man.

Thus one may distinguish :—

(*a*) The harmonised or absolute full load: all parts of the plant are working simultaneously and continuously at full load.

(*b*) The planned (not harmonised) full load; the output of a department for which its plant is built; only some parts of the plant are working at full load (bottle necks) and change this position with other parts, when the kind of product is changed.

(*c*) The practical full load or normal load, kept generally somewhat lower than (*b*). Some means of reserve are not utilised to enable the department to adapt itself more easily to sudden fluctuations of load (changes of delivery dates, insertion of urgent orders, etc.).

It may be pointed out, by the way, that the planned full load (*b*) is not the same as the "stipulated load" used for example as the basis of a budget for a future period. This has to be fixed according to a quite different point of view and is usually considerably lower than (*b*). Whether the normal load (*c*) can also be considered as stipulated load depends on the circumstances of the case.

In order to determine the basis of comparison for the

activity the corresponding figures of load and time must be multiplied.

Standard activity = standard load × standard time.

While the standard time is clearly defined for use in industrial plants as the time which has previously been termed "planned load time," the load itself is either the "planned full load" or the "practical full load or normal load" according to the different purposes for which these considerations may be used in practice. There are, therefore, two different bases of comparison for the activity.

(1) The "planned full activity" or "capacity," *i.e.*, the activity of a works or of a department, which can be maintained continuously during the planned load time according to the lay-out, the plant, the means of transport, the working places, the organisation and the programme of production, without being overloaded.

(2) The "practical full activity" or "normal activity," which is generally lower than the "capacity," say 90% or 85% of it in order to give the works or the department some play for being able to follow sudden changes of the production programme. How, in special cases, the ideas and terms discussed can be used for controlling the production of a department, may be illustrated by an example.

Three furnaces, each of 30 tons planned output in a Siemens melting shop have worked during a period of 4 weeks under the following conditions: production of ingots of the same size and of the same "normal" quality; weight of the melts on the average 28 tons 16 cwts. = 28·8 tons; equal duration of the melts of about 8 hours; all three furnaces working.

The planned full load is, when utilising completely the volume of the three furnaces, and working during 8 hours per melt, *i.e.*, $= 3 \times \dfrac{30 \text{ tons}}{8 \text{ hours}} = 3 \times 3{\cdot}75 = 11{\cdot}25$ tons. The bases of comparison are either (*a*) the theoretical maximum of load as well as time, *i.e.*, continuous working of all three furnaces at highest output during the calendar time, or (*b*) figures attainable in practice with regard to stoppages unavoidable because necessary for relining the furnaces (planned load and time). This results in the table (Fig. 38) of the activity factor of the open-hearth melting shop during the period in question.

| | (a) | (b) | Actual |
|---|---|---|---|
| Theoretical maximum of time .. .. (Calendar time) .. | 1 furnace = 730 hrs. 3 furnaces = 2,190 hrs. | | |
| Planned working time (with regard to relining) .. .. | | 3 furnaces = 1,200 hrs. | |
| Actual working time | | | 3 furnaces = 747 hrs |
| Rate of time utilisation.. .. .. | $\frac{747}{2,190} \times 100 = 34\%$ | $\frac{747}{1,200} \times 100 = 62\%$ | |
| Planned load (output)/furnace .. | 3·75 tons/hour | 3·75 tons/hour | |
| Actual output/furnace .. .. | | | 3·60 tons/hour |
| Rate of load.. .. | $\frac{3{\cdot}60}{3{\cdot}75} \times 100 = 96\%$ | $\frac{3{\cdot}60}{3{\cdot}75} \times 100 = 96\%$ | |
| Theoretical maximum activity (output).. | $3{\cdot}75 \times 2,190 =$ 8,212·5 tons | | |
| Planned activity .. | | $3{\cdot}75 \times 1,200 =$ 4,500 tons | |
| Actual activity .. | | | $3{\cdot}60 \times 747 =$ 2,690 tons |
| Activity factor .. | $\frac{2,690}{8,212{\cdot}5} \times 100 =$ 32·5% | $\frac{2,690}{4,500} \times 100 =$ 59·8% | |

FIG. 38. The activity factor in an open-hearth melting shop.

## E. THE COSTS DEPENDENT ON THE ACTIVITY FACTOR

It is necessary when discussing the dependence of costs on the activity factor always to keep in mind the distinction between the costs of a works, a department or a cost position, *i.e.*, the total costs, and the costs of a special product, either semi-finished or finished, *i.e.*, the costs per unit. The former are especially important for production control, the latter more for price fixing and price control, but the problem of the dependence of costs on the degree of activity seems to have quite a different aspect when considered from the point of view of the total costs or the costs per unit.

Not all types of costs—as already mentioned—change in proportion to the degree of activity. This, however, is mainly the case with the costs of direct material and direct wages ; they decrease and increase in proportion to the output, thus they remain the same per unit, *i.e.*, they are so to speak fixed from the point of view of the costs per unit. However, it may be pointed out that all these statements are not strictly correct in the mathematical sense of the word ; they have to be understood with the reservation already familiar to the reader—that mathematical laws cannot be applied to economic problems with the same precision as in pure science. Thus direct wages per unit are generally lower the larger the number of units ordered in one batch ; the price of material is lower if more material can be bought all at once. But if we leave these deviations from the rules aside—and they are not large enough to change the whole character of the trend of costs—the statements already made and now to be made, are correct, and they are certainly very useful for the understanding of how costs are dependent on the rate of activity.

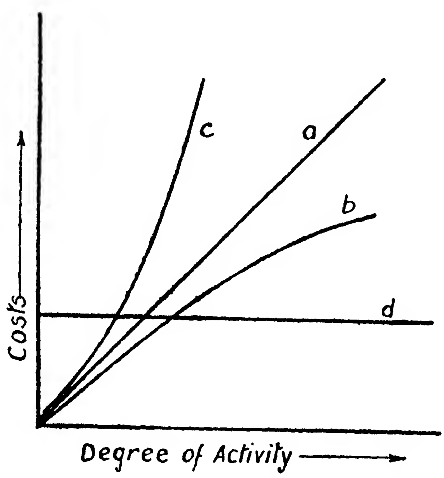



FIG. 39. Total costs dependent on degree of activities.
a = Proportional costs. c = Progressive costs.
b = Regressive costs. d = Fixed costs.

What is said about direct material and direct wages is approximately correct also for some other types of costs : *e.g.*, use of

tools, lubricating oil, wages for transport, maintenance. These "proportional" costs are represented in Fig. 39 by the straight line *a*, through zero point ascending in the same proportion as the activity factor increases, and in Fig. 40 by the parallel to the abscissa.

Other types of costs increase more slowly than the activity factor, when the problem is considered from the point of view of the total costs, and *vice versâ* from the point of view of the

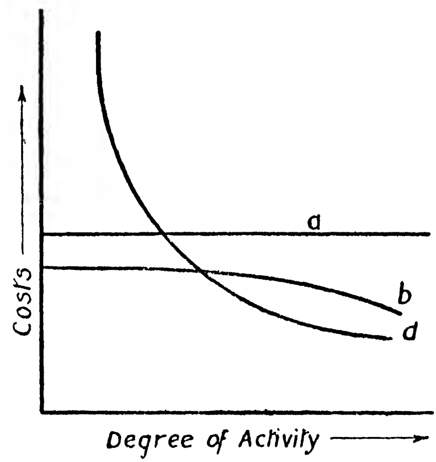



FIG. 40. Cost per unit dependent on degree of activities.

costs per unit. They are termed "regressive costs." As examples may be given: the majority of the salaries, costs of energy produced in the works, auxiliary wages (curves *b* of Figs. 39 and 40).

There are, however, also types of costs, which increase quicker than the activity factor, considered from the point of view of the total costs. They are termed "progressive" costs and are especially of importance in the case of over-activity, *i.e.*, if the works or the department have for some time more work to do than they are planned for. In some circumstances any type of costs can become progressive costs, *e.g.*, wages may increase quicker than the output in consequence of additional payment of overtime and diminished working capability. It may be necessary to depreciate the plant and machines at a higher rate owing to overloading and changing personnel when working two

or three shifts, and the resulting greater wear and tear (curve *c* of Fig. 39).

Finally, some types of costs are not dependent on the degree of activity, at least not if the change in activity remains within certain limits, *e.g.*, some taxes, some salaries, insurance costs, etc. They are termed "fixed costs" because they are constant considered from the point of view of total costs (line *d* of Fig. 39). But when costs per unit are taken into account, these fixed costs are the higher the smaller the output is and they are represented therefore in Fig. 40 by a hyperbola.

It has already been mentioned—but is here repeated because it is considered important enough to be strongly emphasised—that this discussion of the different behaviour of types of costs with changing activity is correct only to a certain degree. Hence, it is justifiable for some purposes to neglect the distinction into regressive and progressive costs of proportional and fixed costs completely and to divide the total costs and the costs per unit respectively into proportional and fixed costs only, particularly as long as the fluctuations of the activity factor are not too large. But this consideration should not lead—as it sometimes does in practice—to the suggestion that the actual behaviour of the different types of costs, when the degree of activity is changing, should not be watched closely. On the contrary very valuable information may be obtained, especially for production control where it is sometimes one of the main objects of the production man to find out whether some costs, up till now considered as fixed, could be converted to some extent into proportional or at least regressive ones. It is also wrong to be superficial by separating the proportional and fixed costs, perhaps putting the former on a par with the individual and the latter with the general costs. There are large parts of the general costs which must be considered as proportional costs.

Furthermore, it must be taken into account that such a distinction cannot be made once and for all; some costs may change their character in the course of time, and only continuous observation can find that out; what is correct in one works, may be wrong in another, as illustrated by Fig. 41. Finally, it is not a matter of indifference as regards costs whether a certain degree of activity is obtained by decrease from a higher or by increase from a lower level. The costs are higher in the first case than in

the second, because some types of costs, as salaries, auxiliary wages, costs of motor cars, etc., cannot be easily accommodated to the change in activity. By analogy with mechanical and electro-

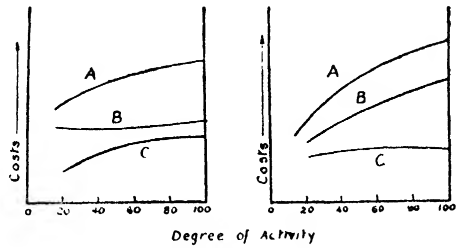



FIG. 41. Comparison between two associated works engaged in the same branch of industry.

A = Auxiliary material. B = Auxiliary wages.
C = Energy costs.

magnetic phenomena this behaviour has been termed the " inertia of the costs " or the " remanence of the costs."

## F. THE CHANGE OF COSTS ACCORDING TO THE ACTIVITY FACTOR

After these theoretical discussions, some practical conclusions may be drawn from the knowledge obtained.

In Fig. 42 the costs of a works are given for three degrees of activity, 100%, 90% and 50%, and in each case they are divided into proportional costs and fixed costs, as this seemed fairly correct in the case of these works. As the absolute figures could not be given for obvious reasons, the total costs at 100% rate of occupation are put as 100, and the other figures are derived from this assumption taking the fixed costs as completely fixed and the proportional costs as completely proportional. Although this may be correct enough for 90% activity it is certainly wrong for 50%, but the necessary corrections will be discussed later on. When it is added that the turnover is calculated supposing that the selling prices equal to the total costs plus 10% and that it is supposed that this selling price does not change when the activity decreases to 90% or even to 50%, the table in Fig. 42 will be self-explanatory.

What is shown in this table in figures, is now illustrated by the graph (*a*) in Fig. 43 which will again be clear without detailed

| | Activity factor % | 100 | | 90 | | 50 | |
|---|---|---|---|---|---|---|---|
| Nr. | Type of costs | Fixed | Proportional | Fixed | Proportional | Fixed | Proportional |
| 1 | Raw material (direct) | | 38·0 | | 34·2 | | 19·0 |
| 2 | Wages (direct) .. | | 17·0 | | 15·3 | | 8·5 |
| | General costs | | | | | | |
| 3 | Depreciation .. .. | 3·0 | | 3·0 | | 3·0 | |
| 4 | Interest on capital .. | 7·0 | | 7·0 | | 7·0 | |
| 5 | Salaries .. .. | 14·0 | | 14·0 | | 14·0 | |
| 6 | Auxiliary wages .. | 0·7 | 5·2 | 0·7 | 4·7 | 0·7 | 2·6 |
| 7 | Auxiliary material .. | 0·5 | 5·5 | 0·5 | 4·9 | 0·5 | 2·7 |
| 8 | Maintenance .. .. | | 1·0 | | 0·9 | | 0·5 |
| 9 | Rejects .. .. | | 0·1 | | 0·09 | | 0·05 |
| 10 | Insurances .. .. | 0·1 | | 0·1 | | 0·1 | |
| 11 | Advertisements, price-lists, etc. .. .. | 2·0 | | 2·0 | | 2·0 | |
| 12 | Commissions .. .. | | 2·0 | | 1·8 | | 1·0 |
| 13 | Rates and taxes .. | 1·8 | 1·2 | 1·8 | 1·08 | 1·8 | 0·6 |
| 14 | Sundries .. .. | 0·8 | | 0·8 | | 0·8 | |
| 15 | Total general costs .. | 30·0 | 15·0 | 30·0 | 13·5 | 30·0 | 7·5 |
| 16 | Partial percentages of direct wages .. | 176 | 88 | 198 | 88 | 352 | 88 |
| 17 | Total percentages of direct wages .. | 264 | | 286 | | 440 | |
| 18 | Addition at full activity in % .. .. | 264 | | 264 | | 264 | |
| 19 | Covered general costs $\left(\frac{264}{100}\times \text{direct wages}\right)$ | 45 $\left(\frac{264}{100}\times 170\right)$ | | 40·3 $\left(\frac{264}{100}\times 15{\cdot}3\right)$ | | 22·5 $\left(\frac{264}{100}\times 8{\cdot}5\right)$ | |
| 20 | General costs non-covered .. .. | 0 (30+15−45=0) | | 3·2 (30+13·5−40·3 = 3·2) | | 15·0 (30+7·5−22·5 = 15·0) | |
| 21 | Total costs .. .. | 100 | | 93 | | 65 | |
| 22 | Turnover = costs at 100% activity+10% | 110 | | 0·9×110=99 | | 0·5×110=55 | |
| 23 | Profit (+) or loss (−) (turnover—costs) .. | +10 | | +6 | | −10 | |

FIG. 42. The change of costs according to the activity factor.

explanation. The vertically shaded space between the lines of the total costs and of the turnover characterises the loss, and the horizontally shaded space the profit. It is obvious that the situation of the point C where these two lines cut each other, is of the utmost importance ; for the more this point C, known as the "critical point," moves to the left, *i.e.*, to the zero-point, the less sensitive are the works to a decrease of the degree of activity.

What are now the conditions on which the situation of the critical point depends ? This can be found by comparing graph

(*a*) and graph (*b*) of Fig. 43. The total costs and the turnover of a works represented by graph (*b*) is for 100% activity the same as those of a works represented by graph (*a*), and so are the costs of direct materials and of direct wages, but the relation of proportional to fixed general costs is different. While in case (*a*) it is 1 : 2, it is 3 : 1 in case (*b*). This has the effect that the critical point moves from the ordinate 75% activity to 50%, *i.e.*, the higher the fixed general costs are in proportion to the proportional general costs the more sensitive is the works or the department to the fluctuations of the activity.

It has sometimes been stated that it is of decisive influence on the situation of the critical point, whether the costs of the wages or of the materials form a preponderant part of the costs ; but this is only indirectly the case. A high share of the cost of materials results in a low share of the general costs, and as the fixed general costs are only a part of the total general costs, their influence is, of course, smaller than when a small share of the costs of material leaves more opportunity to the general costs as a whole and to the fixed general costs in particular to influence the situation of the critical point.

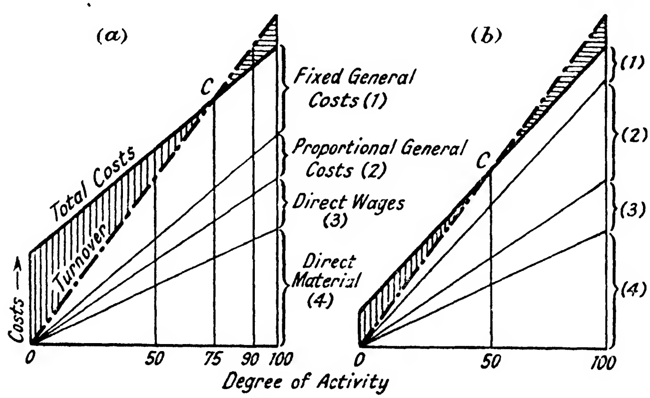



FIG. 43 *a*, *b*. Connection between activity, costs and profit or loss.

One may analyse the graphs (*a*) and (*b*) of Fig. 43 however one likes, the fact remains that the proportion of the fixed and of the proportional costs is the decisive factor for the situation of the critical point.

This fact is of great importance for iron and steel works, where

comparatively high fixed general costs cannot be avoided, they result generally from large and extensive plants, the source of high depreciation, from large stocks of raw material, semi-finished and finished products, which need the investment of large capital; from high salaries for specially trained experts; from the large and expensive organisation and clerical apparatus invariably connected with large works and combines, as iron and steel works nearly always are, etc.

All this certainly means that small works, in consequence of greater simplicity and clearness of the working conditions, are superior to the modern gigantic combines, because these are more endangered by the fluctuations of the market than the former. The latter have to counterbalance this inferiority by cheaper production methods based on their up-to-date plants and machinery and by any possible effort to give the necessary flexibility to their organisation in spite of its extent. What the best solution of this problem is, *i.e.*, which is the most economic size of an industrial undertaking, is frequently discussed, but never exhaustively answered; and it is probable that no general reply can be given. Probably—as in most economic matters—such an answer is possible only in an individual case and is valid for this case only. But there is no question that this problem rises in almost every industrial concern, during the course of its development. That the solution which has been found is not always the correct one is shown very clearly by the history of industry during the last decades, with foundations and liquidations, centralisation and decentralisation by turns, over-organisation and reorganisation, etc. It is not the place here to go more into the details of this problem; but it has been mentioned in order to show for what important decisions the figures developed according to the above lines may be used.

Finally, it may be worth mentioning before the discussion of the factors influencing the situation of the critical point is finished, that the different development of the prices in the costs (material, wages, salaries, etc.) as well as in the turnover can be of importance. If the selling prices decrease earlier or to a greater extent than the prices contained in the costs, the critical point moves to a higher activity factor. In the reverse case, as, for example, at times of inflation, the critical point gives way in the direction of the zero point.

Now it must be reiterated that Figs. 42 and 43 (*a*) and (*b*) give only an illustration of the trend of development in principle; it is attempted in practice to prevent as far as possible the disadvantages which may arise from the rules explained, *i.e.*, the management does what it can do by arbitrary means to take away from the fixed and proportional costs their characteristics, or, in other words, to change the "fixed" costs into not really fixed ones, and the "proportional" costs into not really proportional ones. As a matter of fact it will nearly always be possible to decrease the fixed costs when the activity goes down for some not too short period. If this rate is perhaps only two-thirds of the planned full activity, a set of engines in the power station can be stopped or some employees can be dismissed, etc. If the rate is still only one-third, other or similar measures are used to lower the fixed costs still more: the line of the total costs formed in Fig. 43 (*a*) and (*b*) by one inclined straight line is now converted into several such lines connected by vertical interruptions (see Fig. 43 (*c*) ) and there are several points at which these part lines are cut by the line of the turnover, $c_1$, $c_2$, $c_3$, *i.e.*, the critical point C of Fig. 43 (*a*) and (*b*) is replaced by a series of critical points. Perhaps there is now at 50% rate of activity no longer a loss of 10% as according to Fig. 42 but a small profit instead; it is even possible that at a rate of 66% a higher profit can be obtained than at 85%, etc. Of course, Fig. 43 (*c*) is only a "made

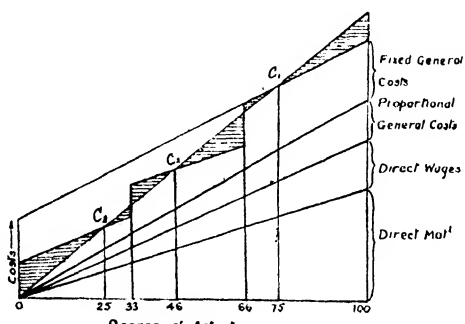



FIG. 43 c. Connection between activity, costs and profit or loss.

up" illustration of what may actually happen: the straight cost lines and turnover lines will actually be irregular curves, as the lowering of the costs may be possible only in small and gradual

steps and the selling prices per unit decrease when the market deteriorates, a fact which mostly coincides with or is even the cause of a falling activity. But the character of the whole development can well be recognised from Fig. 43 (*c*), which is a warning to use the utmost care when drawing conclusions of the development of costs from their state at a certain level of activity.

All the speculations made so often in the literature and used in practice as a basis for the anticipation of costs under changed conditions of activity must be considered, at least to a certain extent, as misleading. For example, the attempt has been made from the knowledge of the total costs and of their composition at 100% and of the costs at 0%, which have been considered as the "fixed costs"—according to Fig. 43 (*a*) and (*b*)—to build up the course of costs for all intermediate degrees of activity. Even Fig. 43 (*c*) although itself still to a large extent a purely theoretical illustration shows how incorrect, if not impossible, the results of this procedure may be. Figs. 43 (*a*), (*b*), and (*c*) should be used only to give clarity to the theoretical connections and there they are very useful. If, however, actual figures are necessary, they can only be obtained by continuous observation of the movement of the costs in the works or departments and by drawing conclusions from this experience. In doing that it is again incorrect to take over from the past without any meditation the figures obtained for a certain activity; it should rather, based on that experience, be considered and anticipated how the working conditions and therefore the costs may differ from those in the past and presumably in future, when the same activity factor occurs again.

That this is no short or easy task which can be done without careful preparation may be illustrated by some examples taken from actual practice. The general way of arriving at a basis for considerations of the future is shown by the Fig. 44 (*a*) and (*b*), the first giving the overheads and direct wages of some department in absolute figures for the 12 months of a year, the second the overheads plotted against the degree of activity, in this case expressed by the amount of direct wages.

In this manner the following three examples of curves have been developed:

(1) Fig. 45. Costs in the central power station of a factory. There were three steam engines which could provide for

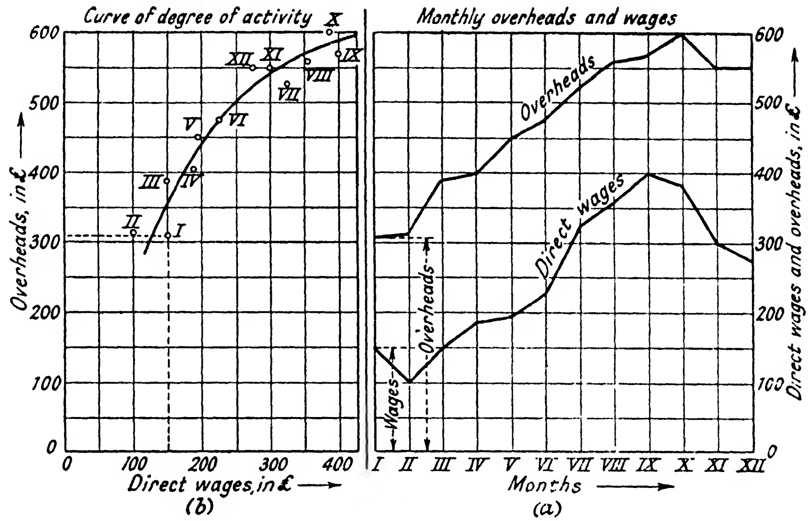



FIG. 44. Conversion of the monthly curves of overheads and wages into a curve of overheads dependent on the degree of activity.

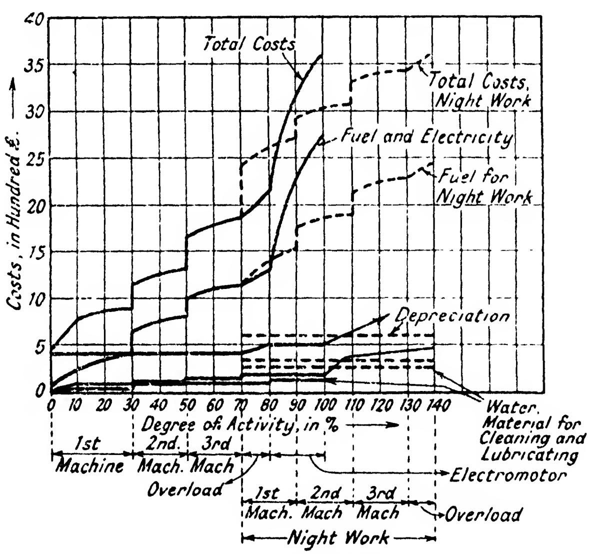



FIG. 45. Costs in a central power station of a factory.

30% + 20% + 20% = 70% of the power needed at a degree of activity of 100%, with a probable overload of 10% during short periods giving 80% altogether. In addition, an electromotor

could be fed by electricity provided by the municipal electricity works and deliver the remaining 20%. When working day and night the three steam engines were sufficient with fair safety for a degree of activity of 140%. The most important types of costs and the total costs for the various eventualities can be taken from the curves, which are the result of statistics of long years.

(2) Fig. 46 (*a*) and (*b*) (page 240). Production costs of a rolling mill, producing nearly always the same classes of goods in the same proportion to each other.

The two figures refer to two different periods, the first from January, 1927, to March, 1930, the second from October, 1930, to September, 1934. This separation into two parts was necessary because economic conditions changed considerably in the meantime, as is obvious from the curves. The upper parts of the figures show how the average curves have been developed from the single points obtained directly by the statistics. These average curves have then been repeated in the lower parts of the figures and have been divided into " fixed " and " proportional " costs, the latter shown separately as " average proportional costs," remaining nearly equal, and as " graduated proportional costs," which show how far it has been possible to adapt these costs to the changing degree of activity. Besides, a curve " additional costs " has been developed illustrating that these are lowest in point A and that the most favourable situation from a costing point of view is characterised by point C where this curve of the additional costs crosses the total costs curve, while B, the crossing point with the average proportional costs, is important as the lower price limit ; it indicates that, at a production beyond this point, the selling at the average proportional costs cannot be considered as expedient (see later).

In order to facilitate the understanding attention may be drawn to the fact that this Fig. 46 refers throughout to the costs of *unit* of production while the first example is concerned with the *total* costs of the power station in question.

(3) Fig. 47 (page 241). Total men-hours per ton of production of a big tube works.

In this case not costs but men-hours per ton are plotted against the degree of activity represented by total equivalent tons of production ; but this cannot be considered as a principal

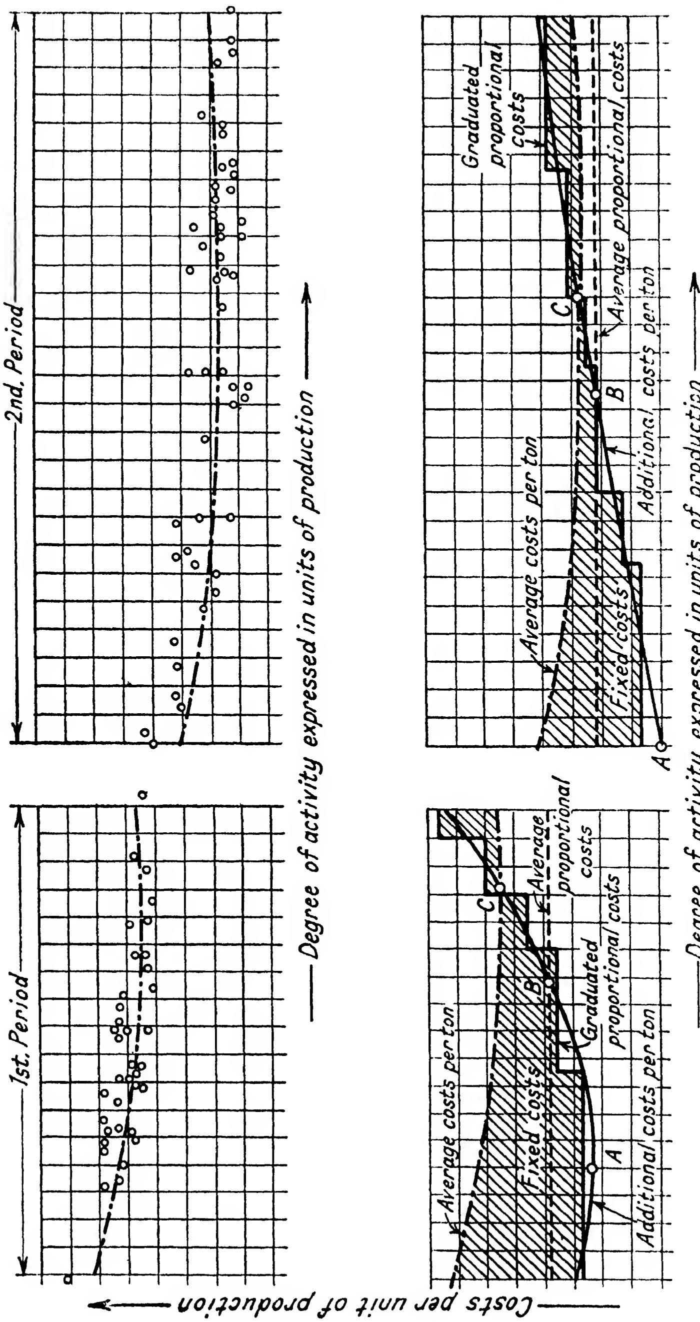



FIG. 46 *a* and *b*. Production costs of a rolling mill, producing nearly always the same classes of goods in the same proportion to each other.

difference as has been explained already in another connection. It may only be mentioned that the hours include all hours worked throughout the whole works, direct as well as indirect, *i.e.*, especially those in the auxiliary departments. These statistics refer to the years 1929 to 1932 and the figures for each month have been inserted separately connecting them by straight lines, and thus forming a limited area signified for each year by a special

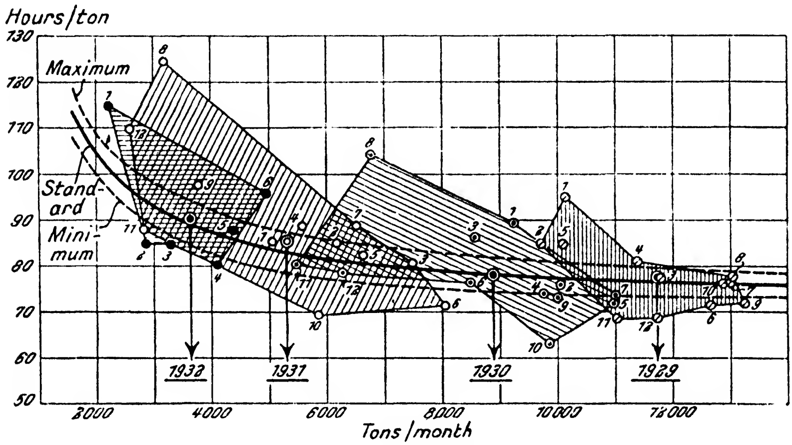



**FIG. 47.** Total men-hours per ton of production of a big tube works.

kind of shading. They give an obvious picture of the actual conditions in the works and allow—by comparison with a curve of " standard values " developed by a special method of " budgeting the working hours "—a just criticism of how far the number of the actual hours has deviated from what should be obtained for the degree of activity in question. As in such considerations some tolerances should always be allowed with regard to the uncertainties of the method applied, two curves parallel to that of the " standard values " indicate the upper and the lower limit of the deviations from the standard. To be sure the actual deviations from the standard are sometimes very high (see August, 1930 and 1931), but they have been caught very quickly by the management and the actual working time is reduced to a figure near the standard.

The author is well aware that the result of the last considerations—that the relationship between costs and the degree of activity cannot be exactly defined but can only be discovered from statistics and experience in individual cases—is not satisfactory to some people. It may be, of course, that their original considerations and conclusions have been the same. Then, however, they have said to themselves: We know that Figs. 43 (*a*) and (*b*) or even 43 (*c*) do not show the truth, but they give at least an approach to the truth and perhaps the best approach we know; what other way can we use but this to come as near to the truth as possible? So far, so good; but now they have used this method so often, that they have quite forgotten that it is only an approach, and they proclaim the quite contestable result as the "truth absolute" and develop even a "system of calculating costs at various degrees of activity" based on this truth. It may be left to the reader whether he will accept such easier but unreliable methods. The author can only recommend the other way which is more difficult, gives no results one can pick out of a prepared table, but procures as a by-product an intimate knowledge of the reaction of the works or the department in question to the measures taken by the management for keeping the costs within reasonable limits.

CHAPTER XVI

# THE CALCULATION OF THE SELLING PRICE AND THE PRICE POLICY WITH REGARD TO THE DEGREE OF ACTIVITY

## A. THE RELATIVITY OF COSTS TO PURPOSE

WHAT was said in the preceding section concerning the influence of the degree of activity on costs is certainly not new : it may indeed be said that ever since costing systems have been used in industrial works it has been felt instinctively that that influence was very important. But the logical consequences of this knowledge have not been followed up. It has already been mentioned that costs have always been considered, at least to some extent, as something really fixed, as figures comparable to those based on facts of physics, chemistry and the like. Perhaps the expert, the accountant, did not make this mistake ; he was well aware of "the relativity of the costing idea," but all the same he was afraid to stress this fact too much for fear of lowering the importance of his work in the eyes of the laymen, and especially his colleagues in the technical and commercial departments. This view should not be taken by any one who wholeheartedly agrees that co-operation for the best interests of the undertaking should be incumbent on all concerned, from the point of view of works economics and national prosperity. Let us be quite sincere : there is nothing absolute about costs. They differ for one and the same object according to the purpose for which they are to be used but this does *not* diminish the importance of the costing system itself or of the services that the costing department could and should deliver to the undertaking as a whole. Admittedly this "relativity to purpose" connected with the costing idea seems at first glance to increase the difficulties in understanding the subject, but on the other hand it enhances the importance of the accountant's work, and if rightly comprehended and followed up to its final consequences, it results in simplification

and reduction of the clerical routine work to the benefit of all. It is the object of the following discussion to explain this more in detail.

The upper and lower limits of the selling price of any goods can be considered the obtainable and the acceptable prices respectively. Both are closely related to the degree of activity.

## B. THE OBTAINABLE PRICE (UPPER PRICE LIMIT)

Every student of national economics learns—and daily life confirms the fact—that the price that can be obtained in the market does not depend only on the costs incurred in producing, selling, and distributing the goods in question. As it is well known, the laws of supply and demand play an important role. In the long run, however, the costs will mainly determine the price or at least its lower limit, as no producer can sell his products for any length of time at a price lower than his costs without becoming a bankrupt. If free competition is possible, the price will depend on the cost in those works which can produce at the lowest costs and can therefore offer the goods at the lowest price without making a loss. The others have to follow them at least for some time, if they do not want to lose the market; those which cannot lower their own costs sufficiently will be eliminated in due course. The result will be that on the whole just enough goods will be produced to meet the demand at a price which leaves a profit to the producer and supplier large enough to be an incentive to bear the risks always connected with industrial activity. The reader will understand that these explanations are purely theoretical; in practice, many possible deviations from this development may occur; nevertheless the connections explained are logical consequences and the course of events behind all deviations in practice must be as indicated. Thus, in the end, the costs really determine the price, not perhaps directly as one is inclined to believe without taking into account the laws of supply and demand, but ultimately by indirectly influencing competition on the market.

[Incidentally, this also answers the often asked question whether it is of any interest to calculate the costs in the case of a "manipulated" market, *i.e.*, if free competition is partially or completely eliminated by a ring or syndicate. Even in that case the prices must finally be based on costs because experience has

shown that no private syndicate is strong enough to neglect in the long run the laws which govern national or international economics. Whether it may be possible to evade these laws by governmental action is still undecided; we are in the midst of this struggle and it would be presumptuous to anticipate the result.]

The costs per unit of production differ not only because the various competitors have to pay different prime costs of material, and different wages and salaries or because they use more or less economical methods of production and have good or bad organisations, but primarily because they are mostly working at different degrees of activity. It has been explained that the higher the degree of activity in a works is, up to the limit of full capacity, the lower are the costs per unit of production, *i.e.*, the lower the prices which can be offered to the customers. From what has been said about free competition, the obtainable price will therefore show the trend to be based on the costs in a concern working at full capacity. That is clear also from the definition of "planned full capacity" in a works, as given above. This state of affairs exists at a load which, according to the plan of the plant, the area of the works, the number and kind of the workplaces, the means of transport, the production programme and the organisation, can be borne continuously during a planned working time without over-exertion. It would be a contradiction of the principle of working economically, not to attempt to do this work with the least possible expense and therefore to plan it with that end in view. It may be that in practice this result cannot be obtained completely, because it is difficult to plan a plant and production without compromises due to practical difficulties; but the deviations from the original plan are not so large that they would endanger the final result to a decisive extent. Thus the conclusion can be drawn that the costs per unit of production are least when the plant is working at full capacity.

The consequence is that these costs form an important basis for calculating the obtainable price, so far as that price *can* be determined by calculation. Some of the reasons why this is possible only to a restricted extent—*e.g.*, the law of supply and demand—have been already mentioned; but there are other considerations which should not be overlooked. Continuous working at full capacity is not so favourable in practice as might

at first be imagined. Where this state of affairs prevails the production lacks the necessary flexibility. Sudden changes in orders, in the disposition of labour, in dates of delivery, and stoppages due to breakdowns, etc., which are unavoidable in industrial works, cause more trouble in production departments working at full capacity than in those where the activity is somewhat reduced.

It is therefore common practice to plan the works for a somewhat larger capacity than it is intended to use continuously. Thus the *planned full activity*, which can certainly be maintained by the plant, but is not desirable for any length of time, must be distinguished from the full activity in practice which can be considered as the "goal" of the works manager, and to which the term *standard activity* may be applied. As all works in the same branch of industry endeavour to attain this standard activity representing simultaneously the lowest costs per unit of production obtainable in the various works, it can be understood that the obtainable price should be based on these costs which may best be termed *standard costs.*

Considering market fluctuations due to the march of events or seasonal influences, it is clear that in times of depression the activity in the works will be lower than the standard activity and the costs may be so much higher that no profit can be obtained or even a loss results. If the works is to be strong enough to overcome such difficulties it must build up a reserve in times of good business, *i.e.*, to make the margin between standard costs and prices correspondingly high ; on the other hand it would be unwise to put the price too high as this would certainly diminish the demand and bring on the danger of decreasing activity in the works. For generally the purchasing power of the customers allows only for a certain maximum price, and as soon as the price surpasses this limit decreased demand will be the inevitable consequence.

Time and time again attempts have been made by agreements between competitors, to adapt the price in times of depression to the actual increased costs, *i.e.*, in comparison to the standard costs ; but where success has been obtained, it has always been of short duration. High prices artificially maintained are an incentive to undercutting ; and when the depression lasts some time there are always competitors who do not resist this tempta-

tion so as to attain higher activity in their works, and thus to lower their actual costs and assimilate them to the standard costs. In other words, the result of this undercutting is that the price tends to be based on the standard costs. These costs are, so to speak, the " water-gauge " of the obtainable price : times of high activity caused by seasons of favourable economic circumstances, and price agreements between competitors allow the price to increase above the level indicated by this " gauge " ; on the other hand, works with insufficient orders on their books lower it under the gauge level by undercutting.

In any case standard costs are the best basis for calculating the obtainable price, not only for the reasons given above, but also because each undertaking is able to work up its own standard costs either from the costs as determined during a period of operation at almost full capacity, or, if such a time has not yet occurred, by estimation based on the costs during the period of operation at the highest capacity already attained.

It need scarcely be mentioned, but may be added for completeness, that this discussion is of no importance in the case of a monopoly, *i.e.*, based on patents, scarcity of raw material, etc. Then the price is almost independent of costs and would be estimated according to the utility of the goods and the capacity of the market.

In order to show the effect of these considerations on the obtainable price, an example may be useful. A colliery needs a hauling plant and asks various factories for tenders. One of them is working only at 40% of its standard capacity, while it is known that its competitors are in a somewhat better position. If the price is calculated according to present circumstances that factory would determine the total costs as follows :

| | |
|---|---|
| Raw material ... ... ... ... | £1,000 |
| Wages ... ... ... ... ... | £500 |
| Overhead costs—500% of the wages... | £2,500 |
| Total costs ... ... ... | £4,000 |

It is clear that it would be futile to ask a price based on this figure ; but how can the obtainable price be calculated even approximately ? There is no market price for such a plant and the firm does not know the method of calculation of its com-

petitors, particularly their percentage addition for covering the overheads. On some other occasion, however, a short time previously orders could be obtained at satisfactory prices when the factory was operating nearly at full capacity. At that time the percentage addition was about 300% and the total costs of the plant would have been £1,000 + 500 + 1,500 = £3,000. This figure has to be used as basis for price calculation if the firm wants to compete successfully for the order.

## C. THE DETERMINATION OF STANDARD COSTS

The standard costs are known without further calculation when there has been a period during which the works have been operating at standard capacity and all costs have been carefully recorded during this period. It must, of course, be assumed that this period has not been too short ; for otherwise figures might be used which should be regarded as mere chance figures. The period must be long enough to be divided into two parts at least, the results of which could be checked by each other. Moreover, these previous figures can be used as a basis only if the circumstances of production, *e.g.*, production machines and methods or the composition of the product, have not been altered in the meantime. If this is the case, corresponding corrections are necessary, which must often be based on special investigations in the production departments such as work and time studies. These should be carried out by experts with sufficient technical knowledge and experience ; for frequently such changes at one place in a department produce other changes at other places—and hence changes in costs—which less experienced and trained specialists could easily overlook.

If the highest degree of activity ever reached in the works falls far short of the standard activity, the standard costs must be calculated and estimated throughout. Everything that has been explained previously about the influence of the degree of activity on the development of costs must be kept in mind and carefully taken into consideration. Thus it may be necessary to convert even the proportional costs, as perhaps the raw material could be bought more cheaply in larger quantities when the works are operating at standard activity than when at only partial activity ; piece-work prices for 5 to 10 pieces are perhaps 5% to 10% lower than for one piece, and may be 25% lower for larger batches.

It is obvious, however, that first of all it will be necessary to correct the fixed costs One type of costs after the other must be investigated, to find out how they may be changed by the transition from the highest activity up to date to the standard activity. For example, the salary account should be considered person by person. It may be that the sum of the salaries of the draughtsmen should not be increased as new drawings are not exceptionally necessary, the increase of activity being brought about merely by increasing the number of the individual batches, not by the introduction of new products. The sum of the salaries of the employees in the production departments, however, needs an increase, as more foremen and more clerks in the wages office or in the planning section are necessary, but this increase will probably be less than that of the degree of activity. On the other hand, the wages of toolmakers and transport workers may increase proportionally to the degree of activity, etc. These remarks may be sufficient to indicate how this conversion can be carried out, and simultaneously to show that this is not an easy job, but a very responsible one and one completely outside routine work. Intimate knowledge of the technical processes, of their connection with each other, of the organisation of the departments, of the conditions of labour and, of course, of the whole costing system, is absolutely necessary if this work is to be carried out in such a manner that the management can, without apprehension, make the important decisions which may be based on the knowledge of the standard costs. Moreover, the development of standard costs is no single event. When standard costs have been worked out and are in use in a works, continuous observation is necessary in case something may happen that might produce a change in the figures obtained. These changes must be carried out quickly and brought to the knowledge of all concerned so that no wrong conclusions may be drawn from the old and now obsolete figures. Where necessary, objections must be cleared up by explaining how the new figures are arrived at ; for these standard costs are a sign-post for everyone ; it is not sufficient to show a man the figure ; he must also be convinced that this figure has been obtained fairly and properly.

The average costs often used in practice as the basis of price calculation instead of standard costs must give wrong results if they are not obtained during a period of standard or at least

nearly standard activity. These average costs are obtained as the average of some months, a quarter, a year or even some years, and it has been claimed that the use of the average method removes to a certain extent all fortuitous figures, so that the result is more accurate than that obtained by the calculation of standard costs. It is further said that if, for example, the average costs of the last two years are used, the fact that the works could exist for two years without becoming bankrupt would be sufficient proof that the selling prices did cover the costs sufficiently, because otherwise a loss would have been shown by the balance sheet. There is certainly some truth in the first of these statements, as any averaging method more or less eliminates the influence of contingencies, just because these contingencies are single happenings whose influence disappears in the mass of other figures used for building up the average. But this elimination of chance figures can be effected as well or even better by developing standard costs in the manner described above. Where such figures really appear in the original cost data, the careful observer, watching the costs continuously, will soon find out which costs are the result of the usual work and which must be attributed to such contingencies and therefore eliminated when developing standard costs. It can even be expected that the result will be more exact than with the average method, where the influence of such incidents is only decreased but not entirely eliminated. The second reason, however, can only be considered as self-deception. Even supposing that in the last two years the costs have been sufficiently covered by the selling prices, that gives no surety that the same will happen in the future. Those who know what enormous changes occur in the course of two years even in works managed most conservatively, will agree that statistical figures, even if only partly based on such a long time ago can never have the value of those estimated by an intelligent observer of the development during the last few months. Further, when the average method is only based on the last few months, it loses the only good quality it has, *i.e.*, that of being built up from a large number of figures, which give a certain guarantee of accuracy *if* they are comparable enough to be used in the same set of statistics.

The graph Fig. 43 (*c*) can be developed into a "standard cost diagram" by connecting the zero point with a point representing

the total costs at a degree of activity of 100% (see Fig. 48). This line shows for each degree of activity the total costs which would ensue if it were possible to adapt the costs completely to the changes of activity. It has been explained that this is not possible in practice and the actual costs are therefore not illustrated by this line, but perhaps by the graduated line; the difference

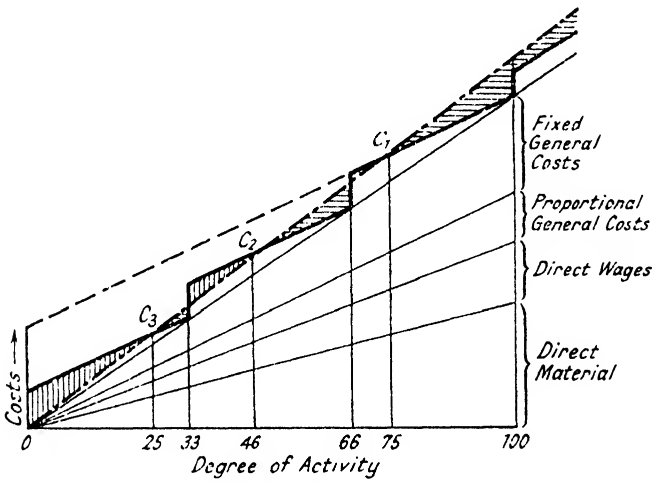



FIG. 48. Connection between activity costs and profit and loss.

between them shows how far the actual costs for each degree of activity deviate from the standard costs which can be considered as "ideal." Thus the management should always endeavour to reduce the differences between the actual and the standard costs as far as possible knowing that it will not succeed in completely eliminating them and therefore not blaming anyone as long as the differences do not exceed an amount that can be considered as permissible.

However, since the standard costs have been based not on the planned full capacity of the works, but on a smaller one in order to give flexibility in case of sudden changes of the production programme, it is quite possible that the actual costs may approximate very closely to the standard costs; cases have indeed been known where standard costs have not only been attained but undercut. Therefore the denotation of standard costs as "ideal" should be somewhat modified; it may perhaps be correct to speak of them as a "practical ideal," *i.e.*, an end that can be

reached in practice in exceptionally favourable circumstances, but will remain unattainable in the majority of cases. These explanations may perhaps be considered as sophistry, as a mere "playing with words"; but anyone well acquainted with conditions in practice knows how important it is to define carefully new ideas when introducing them and to make clear to all concerned their meaning and application; otherwise they will only too often become the object of heated discussions and the cause of controversies to avoid which is perhaps just the reason of their introduction.

## D. THE ACCEPTABLE PRICE (LOWER PRICE LIMIT).

Very often the question has to be answered in practice whether an order should be accepted at a low price if no higher one can be obtained by competition. It has already been explained that

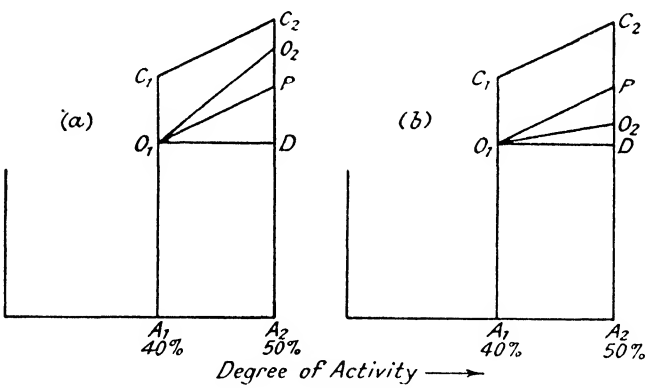



FIG. 49. The acceptable price.

costs are lowest if the works are operating at full capacity. As long as this degree of activity is not reached, the works should attempt to obtain it by accepting new orders. But if these can be obtained only by depressing prices, it must first be found out whether the higher activity will really increase the profit, or if a loss has already occurred owing to the low degree of activity whether this loss can at least be diminished by new orders. The conditions to be considered in this case may be illustrated by Figs. 49 (*a*) and (*b*). The line $C_1C_2$ may represent how the costs

change when the degree of activity increases from $A_1$ to $A_2$, *e.g.*, from 40% to 50% of the full capacity of the plant. $A_1O_1$ may represent the output at an activity A, while the costs are $A_1C_1$, *i e.*, higher than the output. The question is : how much must the output be increased if the degree of activity is increased from $A_1$ to $A_2$ and the present loss $O_1C_1$ is not to be enlarged, but as far as possible diminished ? The loss would not be changed if the output were increased in the same proportion as the costs, *i.e.*, if the increase of the output could be represented by the line $O_1P$ parallel to $C_1C_2$. Any output smaller than $A_2P$ would increase the loss (see Fig. 49 (*b*)) and any output larger than $A_2P$ would reduce the loss (see Fig. 49 (*a*)). If the output at the degree of activity $A_2$ is larger than the costs $A_2C_2$, a profit would result.

A line parallel to the axis of the degree of activity through $O_1$ cuts the ordinate $A_2C_2$ in D and the distance DP shows how much the output must be increased in proportion to the costs, if the profit is not to be diminished or the loss increased.

Considering now, not the total output, but an individual order enlarging the output, the price of this order must similarly cover at least the new or *additional* costs resulting from the carrying out of this order ; otherwise the profit would be smaller or the loss larger than before. This price is the lower price limit and can be termed the *acceptable price* ; but it should be added forthwith that this price can be accepted only, if need be, in individual cases, and even then only on the assumption that for other orders, especially when business has improved, prices can be obtained which include not only the costs but such a large profit that the smaller profit or loss of the former order can be counterbalanced. It is obvious how dangerous this method of quoting would be if it were applied too often or even generally during a time of depression. (One would soon be in the position of the retailer who bought herrings at 3d. each, sold them for a penny less, and when asked by his friends how he thought to obtain the necessary profit, answered : That is only possible by selling large quantities.)

Furthermore, it is obvious that the calculation is correct only if the line of costs $C_1C_2$ between the two degrees of activity $A_1$ and $A_2$ is a straight line, and former considerations have shown that that is very often not the case. Still it can be assumed with sufficient accuracy if the distance between the two degrees of

activity is not too great and if no special changes in the structure or organisation of the works would result from the increase in activity, such as an increase in the number of employees, arrangements for overtime against additional payment, etc. These sudden changes of costs cannot be dealt with generally. They must be taken into account individually and are not included in the following considerations.

The price calculation as indicated by Fig. 49 is sometimes not applied as the work is regarded as too complicated and difficult. It is considered as sufficiently accurate to take the whole general costs as fixed costs and only direct material and wages as additional costs. But this is definitely a mistake, and it may easily lead to too great reduction of the price and increase the loss instead of diminishing it. A part of the general costs is in any case changing proportionally to the degree of activity, and it is very important to know at least approximately how large this proportional part is in order to be able to take it into consideration when fixing the price. Moreover, detailed consideration shows that the more accurate calculation indicated above can be carried out in a comparatively simple manner, either by graphical or arithmetical methods.

In the first of these two cases one has only to follow the development of Figs. 49 (*a*) and (*b*). Provided that the trend of the costs dependent on the degree of activity between two activity factors $A_1$ and $A_2$, *i.e.*, the course $C_1C_2$, is known, the original output, represented by the line $A_1O_1$ may be increased to $A_2O_2$ by an order the acceptable price of which has to be found. This price is equal to the line DP, the two points D and P being determined by drawing parallels to the abscissa and the cost line $C_1C_2$ respectively. If P is situated below $O_2$ (Fig. 49 (*a*) ) the new order can be accepted. If, however, P cuts the ordinate $A_2C_2$ above $O_2$ (Fig. 49 (*b*) ) acceptance of the new order cannot be recommended from the aspect of profitableness of this individual order alone, but if other reasons are important enough to overcome this consideration, it is valuable to know that not only are the fixed costs which the order should normally bear not covered, but also a part of the proportional costs as represented by the line $O_2P$.

Familiar as such graphical methods may be to the technical members of the staff, the costing department will usually prefer

arithmetical methods ; not that the accountant would fail to understand the simple graphs explained, but that he has to take into account the majority of his staff, who often have difficulties in understanding graphical methods. The arithmetical calculations may therefore be explained more in detail.

For the present purpose the costs of direct material and direct wages can be taken as proportional to the degree of activity if no special conditions such as those mentioned above enforce a deviation which must be taken into account separately. When estimating or anticipating the general costs the ratio of the proportional to the fixed general costs is of importance. This ratio is usually known from the routine cost control. If not, it can be determined by a method similar to that given in Fig. 42. Of course, this has to be done for the activity factor in question ; for the fixed general costs are as explained not actually fixed, but depend to some extent on the activity factor and consequently the share of the proportional costs on the total general costs changes (see Fig. 43 (*c*) ). For example, in this figure the fixed costs at 75% activity factor are different from those at 66%, and at 33% different from those at 45%. The ratio of the proportional costs to the fixed costs changes correspondingly. This ratio is the basis for the addition to be made to the direct wages in order to cover the proportional general costs. If, for instance, this ratio is 2 : 3 and the total general costs are 225% of the direct wages—a figure usually known from the routine cost control—the

proportional costs are $\frac{2}{2+3} \times 225 = 90\%$ of the direct wages

and the additional costs arising from a new order are : costs of direct material + 1·9 × direct wages. It may, however, be emphasised again that this figure 1·9 depends generally on the original activity factor and will probably change if another activity factor has to be taken as starting-point.

This addition representing the proportional general costs can be determined for the whole works as well as for each cost position separately. The latter method is necessary if the costs at the various cost positions change in differing proportions when carrying out the new order in question. That may be explained by an example :—

The acceptance of an order, the economic importance of which

is at least questionable, may increase the individual costs of production as follows :—

| | |
|---|---|
| Costs of direct material $m$ .. .. .. | £100 |
| Direct wages for handwork $w_h$ .. .. | £30 |
| Direct wages for machine work $w_m$ .. .. | £20 |

The percentage addition for proportional general costs may be : at the cost positions (handwork) 60% $= 0{\cdot}60 \times w_h$ ; at the cost positions (machine work) 40% $= 0{\cdot}40 \times w_m$. The total proportional costs are then : $100 + 30 + 20 + 0{\cdot}6 \times 30 + 0{\cdot}40 \times 20 =$ £176. If the increase in costs takes place not only in the main shops, but also in auxiliary cost positions, *e.g.*, if special design work or change of patterns, etc., is necessary for the new order, these costs must be taken into account separately. Of course, this kind of calculation, which one meets frequently in practice, can be applied only in so far as it can be assumed with sufficient accuracy that the activity factor changes proportionally to the direct wages.

Generally the costs of a new order can be calculated as follows :—

Let :

$C$ = the total cost of the concern
$M$ = the direct material costs
$W$ = the direct wages
$G$ = the total general costs
$p$ = the share of the proportional costs and
$f$ = the share of the fixed costs on the general costs, these general costs being put equal to 1, *i.e.*, $p + f = 1$
$b$ = the change in the activity factor, expressed not in per cent., but in fractions of 1.

Then the change in the general costs is $b \times p \times G$. For example, the activity factor may increase 10% ($b = 0{\cdot}1$) and the proportional part of the general costs may be 30% ($p = 0{\cdot}3$) ; in consequence the increase in the general costs will be 3% ($b \times p \times G = 0{\cdot}1 \times 0{\cdot}3 \times G - 0{\cdot}03\,G$) ; in other words, an increase of the activity factor of 10% raises the general costs 3% under the given working conditions.

The importance of these considerations may be emphasised by a second example using actual figures. The costs of production in a concern at the present activity factor are : direct material

£2,000 ; direct wages £1,000 ; general costs £2,000, of which 50% can be considered as proportional costs. There is a new order that can be obtained at the price of £210. The question is whether it should be accepted or left to the competitors. The estimated costs of direct material and direct wages for this order are £100 and £50 respectively ; thus the output may be increased 5% by this order. Based on these figures the calculation of the additional general costs results in $0{\cdot}05 \times 0{\cdot}5 \times 2{,}000 =$ £50 and the total costs of the new order amount to £100 + 50 + 50 = £200, while they would, if all general costs were proportional, amount to £100 + 50 + 100 = £250.

As the actual obtainable price, £210, is in between the costs calculated in the usual manner (*i.e.*, with the present percentage of direct wages for covering overheads) and the additional costs, which cover only the proportional part of the general costs, the order can be accepted as long as this kind of business is considered as an exception and does not degenerate into a habit.

The same or similar considerations apply if the question has to be answered—as is frequently the case—whether some object, a tool, a jig, a gauge, etc., should be manufactured in the workshop itself or bought from an outside supplier. First of all it is necessary to know the activity factor in the workshop. Very often the calculation is carried out without due regard to this factor and the result may be absolutely wrong. For example, suppose the workshop has a low activity ; nevertheless the general costs are taken as 300% of the direct wages and the costs of some tool are calculated as : material £3, direct wages £1 10s., general costs £4 10s., therefore total costs £9, while a supplier, known as a good manufacturer, gives a tender of £7 10s. for exactly the same object. It is however obvious that the manager of the shop concerned needs work to keep his trained and skilled men, who may be lost if working time has to be reduced too much owing to lack of work. It is permissible in this case to use the following calculations : material £3 ; direct wages £1 10s. ; proportional general costs = 100% of the direct wages, *i.e.*, additional costs, arising from the order in question £6 ; fixed general costs = 200% of the direct wages = £3 ; total costs £9 as before. Now, however, the *additional* costs of £6 can be compared with the price of the outside supplier, *i.e.*, £7 10s., and the calculation allows of carrying out the job in the firm's own shop.

The decision may, however, be very different when the shop is working at normal load, or even at full capacity, so that a new order would perhaps mean overtime or the engagement of new men, etc., and the costs would increase " progressively." Such a calculation in fact is valid only " under present working conditions " and has to be repeated as soon as they have changed considerably. The result should further be regarded only as one of the various factors which must be taken into account before making a decision. Other factors influencing the decision may be the special experience of the outside supplier, the necessary date of delivery, the secrecy of the drawings necessary for the production of the object in question, etc., *i.e.*, mostly matters the value of which cannot be easily expressed in £ s. d. ; but it will always be useful to know from the calculation the financial effect of the decision as it will be contained in the final statement of profit or loss in the shop concerned.

Useful as it is to comprehend exactly what is meant by the term " acceptable price " and to apply this knowledge in suitable cases, the above discussion should have made clear how dangerous it is to exaggerate this application. Another point of view, which is often neglected but is nevertheless of great importance even for the individual works, is that of the industry as a whole, or at least of the branch of industry concerned ; for everything detrimental to the whole will eventually develop into a disadvantage for each of the individual works. If there is one firm undercutting the prices, the other firms in the same branch of industry must follow in due course ; if one competitor abuses the idea of the " acceptable price ' by exaggeration, the others are soon forced to do the same. Thus very often the whole branch of industry is brought down to the lower price limit or to a still lower level. As a rule, in such cases the purpose of the undercutting, *i.e.*, a higher activity factor, is not even attained, at least not in the long run and not generally. The individual concern which starts the undercutting can perhaps temporarily improve its degree of activity, but as the total turnover of a branch of industry is limited by the purchasing power of the population, and in times of depression this power cannot be increased above a certain level even by very low prices, the final result of undercutting is only that the obtainable business is done at a lower price level. This diminishes the general profit or even

changes it into a general loss. Experience has shown only too often that these considerations are of eminently practical importance. It may therefore be repeated that the use of the lower price limit for the sales policy of an undertaking should be restricted to cases of real emergency, when the existence of the concern is at stake.

## E. STANDARD COSTS *v.* ACTUAL COSTS

It has been explained that the best basis for the calculation and fixing of selling prices are the standard costs ; it is, however, very seldom that the actual costs, as they arise when an order is really carried out, are the same as the standard costs. They will be either higher—in the majority of cases—or lower, if the works have operated even more economically than had been expected for working at the standard activity factor, *i.e.*, a degree of activity only to a small extent less than the planned full capacity of the works would allow. (It may be recalled that this margin between standard activity and planned full activity of the plant was chosen in order to allow for some flexibility in the plant in case of unforeseen changes in the production programmes.)

The difference between anticipated standard costs for any products, and the actual costs of the same products when produced in the shops at the time of any activity factor different from that valid for the standard costs, can be either a loss (in the majority of cases) or sometimes a profit. The question has to be answered how this difference can be dealt with in order to maintain the necessary connection between the costing system and the accountancy, to ensure that the costing figures are correct as far as desirable in practice. The profit or loss for each product on each special order can be shown separately by using the actual costs as given in the shop vouchers which form the basis of the accountancy figures, and by putting together these figures in a form of " post-calculation " ; in this, the general costs are calculated by means of an actual ratio of general costs to direct wages, as they can be taken from the cost figures during the time of the actual production. It is, however, also possible to credit the profits or to charge the losses as a whole during a certain period, say a week or a month, to the production departments

where they have arisen. The first of these two methods was formerly the usual one and can still be found in many works, where this "complete calculation of the actual costs of all products of the works immediately after their production" is an object of pride on the part of the manager of the cost department. There is, however, the question whether the huge work connected with this "post-calculation" gives such valuable results that its continuance year in year out is justifiable.

It is the author's opinion that nobody who has looked at the use that has been made in most of these works of the figures finally compiled by this "post-calculation" can answer this question by a definite yes; and this opinion must be considered as the more justified the more the production in a works has been developed from single to batch or even mass production. This means that this kind of "post-calculation" *must disappear from iron and steel works*, perhaps with the exception of rare cases where a close investigation of actual costs for a limited time may be considered as necessary for a special purpose.

It is, however, not only the utility aspect that should be considered when it has to be decided, whether this former kind of "post-calculation" of actual costs should be continued or abandoned in favour of the second method of using standard costs. Are these actual costs really "actual" in the sense that they have arisen in the production of the goods concerned and in that production only? Apart from the repeatedly mentioned uncertainty always connected with cost figures, it is only necessary to investigate the differences in the actual costs of one and the same product produced at different time in the same works. These differences are perhaps caused by different activity factors in the shops concerned. Can the product in question be made responsible for this fact? Certainly not; the work to be done in producing the article was most probably the same at the time of the low activity factor as it was when the factor was high, and the difference in costs is only caused by this fact of various activity factors during the various times of production. That, however, has to do with the *department concerned*, not the *products* manufactured in the department. It is therefore only logical to disregard the product completely when dealing with the difference

between standard and actual costs and to charge the profit or loss to the department or shops.

One could express this result by stating that the costs really caused by the production of certain goods are the same at each activity factor, and that all other costs are "costs of readiness," of being prepared to do the actual work in the shops, costs arising from the fact that the whole production plant of the works, of a department, or a workshop must be available, even if all of it is not necessary under the momentary working conditions. It is therefore senseless, although one hears it again and again, to ask for the "correct costs"—an expression regarded as identical with the "actual costs" as they can be developed from the vouchers and books of accountancy. It can be stated of these actual costs only that they have been "correct" in one special case in the past; it cannot be taken for granted that exactly the same costs will arise again in future even under the same working conditions. The false conclusion that is generally made with regard to the correctness of the actual costs based on accountancy figures, is made especially clear in those branches of industry where the making of a product, *e.g.*, a ship, a locomotive, a lorry, etc., takes a longer working time than is contained in a week or a month. The various percentage additions for the general costs are mostly built up as an average and therefore do not change during the working period, but change from week to week or month to month. As these cases of production occur seldom if at all in iron and steel works, they need not, however, be discussed in detail.

The result of these considerations, a result of the utmost importance for the whole development of cost accountancy, is that :—

> The actual costs based on the figures of accountancy should be determined periodically (weekly, monthly), but only for the works as a whole, or for a department or a workshop; the use of actual costs when calculating the costs of an individual product is misleading and should be omitted entirely.
>
> Only standard costs should be used as the costs of an individual product since the latter are to be developed for the usual calculation of the price of the product without

any regard to the activity factor at the time of the production, or to whether the final fixing of the price is really based on these standard costs or cannot be so based because of market depression or other reasons.

## F. CONNECTION BETWEEN COSTING AND ACCOUNTANCY WHEN USING STANDARD COSTS

Assuming "the work in production account" used in the accountancy ledgers has been built up in the forms as formerly described in detail,[1] *i.e.*, divided into four accounts :

Material in production,
Wages in production,
Overheads in production, and
Percentages of wages in production,

it is possible to show clearly and continuously the difference between the actual general costs and the standard general costs on one account, *i.e.*, "the overheads in production account." It is only necessary to discharge this account by amounts corresponding to standard percentages instead of those calculated according to former working conditions, as shown in the example quoted. In this it was estimated on the basis of previous experience that the percentage would be 150%, while the actual percentage turned out later on to be 145%. If instead of this specially calculated figure of 150%, the percentage used for calculating the standard costs had been taken, say 125%, the balance in the "overheads in production account" would represent the difference between the general costs as found from the figures of accountancy on the one side and according to the standard costs calculation on the other side. Similarly accounts can be inserted behind the material-in-production account and behind the wages-in-production account—transitional accounts for converting the object of these two accounts from actual cost figures into standard cost figures. Thus, for example, the consumption of 5 tons of material at a stock price of £5 per ton would result in the charging of £25 to the transitional material-in-production conversion account and in the crediting of the same amount of material, but calculated at a standard price of, say,

[1] See pp. 9 to 12.

£4 10s. per ton, *i.e.*, £22 10s. in all, before charging the finished goods account with this sum of £22 10s. Thus a balance of £2 10s. would remain in the conversion account showing the difference between the actual and standard costs in this particular case. The conversion of the wages-in-production account would be used in a similar manner if differences arise between the direct wages actually paid and the standard wages. The addition of the three balances of the three conversion accounts : overheads-in-production, material-in-production, and wages-in-production (these balances being taken as positive if indicating a loss and negative if indicating a profit), results in the actual costs exceeding the standard costs in the case of a loss, and the standard costs exceeding the actual costs in the case of a profit. The first of these two cases will be the rule, while the second will occur only exceptionally, for the standard costs have been defined in such a manner that they can be considered as a " practical ideal," *i.e.*, they can be reached or even undercut in practice, but only seldom and in particularly favourable circumstances.

When considering this discussion the reader may feel that the procedure recommended seems to be rather complicated and unsuitable for application in practice ; it may even be thought that the splitting of the work-in-producton account into six separate accounts, three main and three transitional, means an overdoing of an idea which may be correct theoretically but involves too much clerical work to be economically justified. Experience has shown that this is incorrect : regard must be had to the fact that it is not a matter of splitting figures into three parts, but of booking of available figures in three different accounts instead of adding three of these figures and booking the sum on one account. Further, the calculation of standard material costs and standard wages causes only slight additional work, if the material requisition forms and the wages tickets are suitably printed, *i.e.*, contain spaces in which the standard unit figures of material and wages as well as the total standard costs of material and wages respectively can be inserted. Any increase in clerical work is more than counterbalanced by the clearness of the result. It is then known how great the difference between actual and standard costs is for the department concerned, and this difference is split up into the three factors : material, wages and overheads. The continuous observation of these figures, and

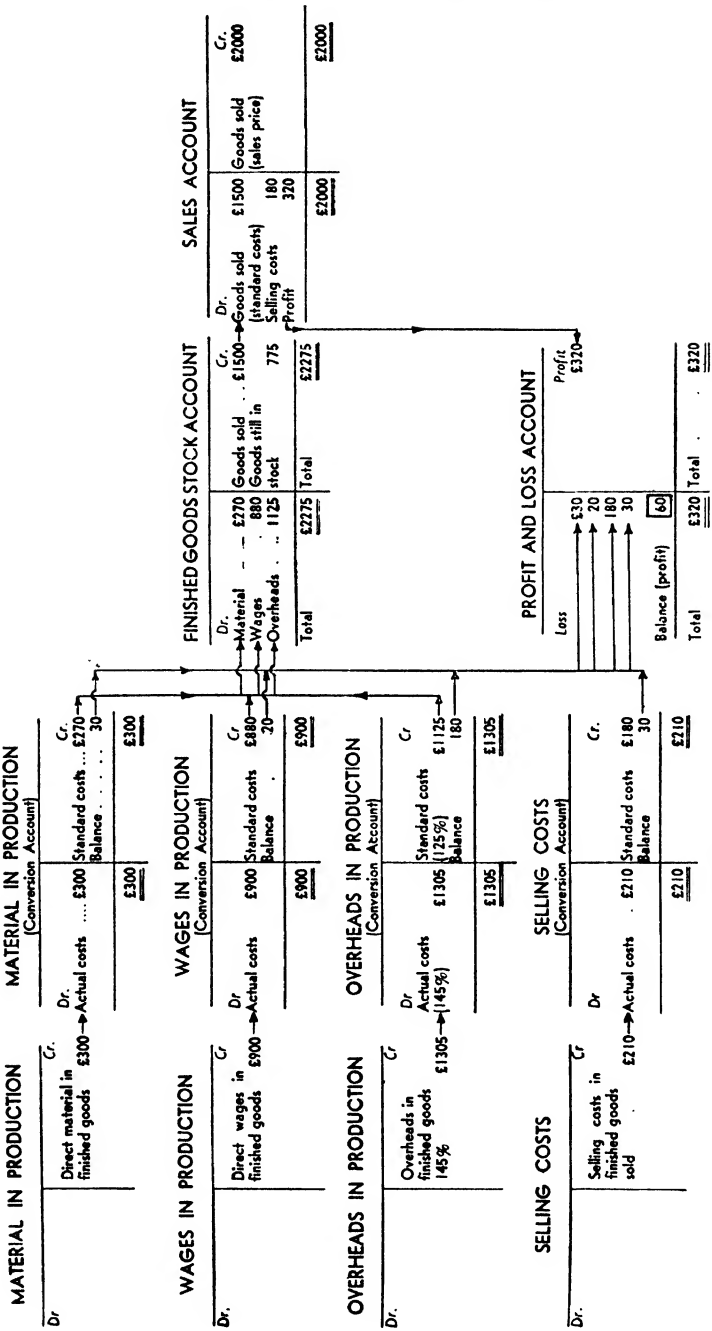



FIG. 50. Connection between costing and accountancy when using standard costs.

of their fluctuations as perhaps illustrated by graphs with the time as abscissa, or if plotted against the corresponding activity factors, is a great help in production control.

Similar conditions prevail in the sales department; standard costs can be also developed there and compared with the actual costs; the difference, loss or profit, can be shown in a conversion account, and in both cases for production as well as sales, these differences will finally disappear from the books of accountancy into the profit and loss account. After what has been discussed Fig. 50 needs no further explanation. It remains only to repeat that this procedure, at first so often attacked as too complicated, too artificial, etc., has found more and more friends in industrial works and can sincerely be recommended in the opinion of the author who had the opportunity of observing its application in practice on various occasions.

# CHAPTER XVII

# THE APPLICATION OF STANDARD COSTS

Although it has already been explained in principle where to use standard costs instead of actual costs and figures based on the vouchers coming from the workshops and stores, it may be useful to dwell a little longer on the question of the application of standard costs as this leads to problems of organisation closely connected with costing and largely considered as vital characteristics of modern management. It will be necessary to explain these modern methods of organisation in industrial works and to point out how far they may affect the economic situation of iron and steel works.

Referring once again to Fig. 1 on the classification of industrial accounts, and considering this figure now from the point of view of the application of standard costs, it can be stated that the domain of standard costs is budgeting and estimating. Budgeting can refer either to the undertaking as a whole and its various functions of investment, production, sale or finance, or to the various workshops and their working time, their output and their costs. Estimating may either deal with the profitableness of a production method, or with the economic situation of a workshop or department, or with the business policy of a whole undertaking or a combine, and may proceed in all these cases to some form of cost comparison, or it may be carried out for tender purposes.

## A. BUDGETING AND PLANNING

**1. Preliminary Remarks and Definitions.** Budgeting an undertaking and its functions is naturally based on the budgeting of the various workshops and departments ; as a matter of fact the same figures are used in both cases ; they are only grouped in a different manner. As the workshops and departments are parts of the whole it is obvious that their figures can be obtained and then combined to figures of the whole more easily than *vice versâ*. Now, budgeting is really nothing else but planning in terms of

money; thus the whole work of budgeting rests ultimately on planning the workshops and departments, and as soon as it is clearly understood what planning means as a part of modern organisation, the transition to budgeting is more or less a matter of common sense dependent in its details to such an extent on the peculiarities of the individual case that it is difficult—but also scarcely necessary—to develop general rules. It may therefore be sufficient to deal in detail with planning only and, it may be added in order to obey the present usage of language, with progressing; for one finds the combination "planning and progressing" used so often that the one term is mearly unthinkable without the other.

This kind of work is often considered as one of the main, if not the most significant, features of modern management, in contrast with what was meant by management, say, 30 years ago. And to a certain extent that is true. On the other hand, one may say that this matter of planning and progressing actually arises from the fact that the manager has become more aware of his duty not to adopt a casual attitude to business events, or to leave improperly trained subordinates to make decisions, but to make his own forecast of business trends and prepare to meet any anticipated difficulties. There is also the feeling—and the author thinks rightly—that executive ability and planning ability are so different, that only rarely is the power to do both in the best possible manner combined in one individual and that allocation of these functions to two different persons would therefore be advantageous.

This is one of the problems connected with the question of the division of labour in this case not of manual but of mental labour; and the difficulties mostly connected with this problem also occur in this case. Organisation may be defined as "the art of using the advantages of division of labour necessary in industry, and of simultaneously avoiding the disadvantages connected with it, as far as possible in the given circumstances" [1]; here, in particular, the organiser has a difficult task in harmonising the many interests concerned. Special attention, however, is necessary, if it is not a new works where planning and progressing must be introduced from the start, but an established undertaking, perhaps grown up from small beginning to a considerable size with hundreds or

[1] "The New Management." 1938. P. 25.

even thousands of employees, where quasi "hereditary" privileges must be abolished, new positions as mediators between old ones created, and only too often new persons from outside must be drawn in, who, apparently, take from the old staff some of their work, and therewith a part of their influence.

In these circumstances, because planning and progressing is such a difficult part of works organisation, it will be understood that it is the object of numerous suggestions: modern literature is full of detailed descriptions of "systems," introduced here or there with great success, and recommended for other cases. Long experience in industrial life has made the author very cautious in accepting such reports as completely true. He has seen more of these "systems" broken down, partly or completely, than working satisfactorily, even if a "recognised authority" had created and introduced them. For devising such a system, and even introducing it on the one hand, and bringing it to life in the works and keeping it operative on the other are two completely different things. Nobody who is responsible for introducing a system of planning and progressing should overlook this fact. If he is not perfectly convinced of the final advantage, if he is not prepared to have sacrifices in the beginning and apparently continuously, if he is not determined to overcome all initial difficulties with quietness but firmness, and if he has not the authority to maintain his policy fully, he had better leave this matter alone; for nothing is more depressing for him and detrimental to his reputation, nothing incites the mockery of his employees more than those corpses of tables of allocation, boards of dates of delivery, etc., which one may see in so many factories, not as a guidance to the shop, but only as a useless picture of what has happened, maintained in more or less good order—mostly in a less one—because the "boss" has introduced them, without having afterwards the necessary interest or time, and without installing the right assistant to look after the "system" and analyse all the results which would be helpful to a real works manager.

One remark may be added to these introductory words before the actual discussion of planning and progressing should begin, a remark which is necessary because so many people are not fully aware of what they are doing when introducing this measure. When moving a function from executive to administrative people

they must, of course, increase the number of the latter, sometimes without diminishing the number of the former, because these can now fulfil their executive duties better than before, and the improved quality of goods produced brings about a greater demand and output ; but even if the latter is not the case, and the ratio of the administration personnel to the executive increases, what does this often-complained " augmentation of the clerical staff " —as it is commonly expressed—matter if the total costs of the produced goods decrease, and the service to the customer is improved by quicker or more accurate delivery dates ?

Besides this economic point of view another may be mentioned —perhaps not considered, or even acknowledged by all readers : is not this development something at which we should aim with all means, increasingly transferring human labour from the manual to the mental sphere ? That is the trend of modern engineering. The central power station has already been mentioned as an advanced example, where men are only switching over this or that lever and are almost completely released from heavy manual work. Of course, in factories generally we are far from that stage ; but the attentive observer can see this trend anywhere. What a hopeful outlook it is, bringing to the mind of the follower of industry the much-too-much-talked-of nonsense of the immanent evil of industrial development.

But let us go back from this philosophical digression to our actual topic.

It is necessary to explain what is meant by the expressions " planning " and " progressing," for these words are variously applied by different people, resulting in dispute and misunderstanding. The following definition may not be accepted by all, but may be considered as a suitable compromise. In any case it explains what is meant by these words in the following discussion.

Planning means establishing a plan based on systematic studies of the existing plant and the work in hand ; how and in which sequence this work should be carried out by the departments, taking into careful consideration the capacity of these parts of the plant. Progressing means forecasting the times for carrying out this plan. In both cases a comparison should be made, as far as necessary, between what actually has happened and what is planned and forecast.

Special attention may be drawn to the words "as far as necessary" in the last sentence. This comparison is meant only as a control, how far the original planning and progressing could actually be realised, why it was, in some cases, not possible to maintain the original purpose, and to draw from that experience conclusions for the future. The mere following-up of what has actually happened—an activity sometimes called progressing—is useless, not worth the money it costs.

It may now be clear that planning and progressing can be done successfully only when the capacity of all parts of the plant is known, which processes the work on hand has to undergo in each case, and what time each of these processes requires.

Only two ways of ascertaining these figures are known—statistics based on former production and time studies. A third way, sometimes recommended, can only be used in rare cases and with extreme caution—*i.e.*, using the figures of capacity given by the producer of the plant. These figures are too often based on experiments in the test-house of the producer of the plant, and may not be realised in the different circumstances in practice.

The statistics can only be based on the first booking of material and wages in the shops, and are reliable only if this booking has been done with the necessary accuracy, as formerly explained. It may be that some figures, as, for example, numbers or other characteristics of the machine used, are needed which are not necessary for wages or costs purposes. Such additions should not be forgotten. Time studies are certainly the most reliable way to find out all the basic figures, but they are often too lengthy for procedure to be based on them alone. It must be left to the man in charge of this work to combine the possible ways in the case in question in the best possible manner.

**2. Carrying out Planning and Progressing.** To deal with the actual operation of planning and progressing it is obvious that "planning" is a work inserted between design and production—*i.e.*, between the development of the form and the quality of the goods to be produced by work in the laboratory or on the drawing-board on the one hand and the actual manufacturing of these goods on the other hand. Simultaneously, however, this planning work forms a link with the commercial side of the undertaking, for it can be divided into four parts :—

(*a*) Analysing customers' orders.
(*b*) Developing works orders.
(*c*) Work and time studies.
(*d*) Progressing.

It will be necessary to explain more in detail what these headings really mean, for in doing so the actual carrying out of planning and progressing will be described.

(*a*) Analysis of Customer Orders. The "raw material" which has to be treated by the planning department is represented by customers' orders as received by the commercial side. It is usual to enter them in an order book in sequence of receipt, and to characterise them by an order number which accompanies the order through all phases of their processing. There are many various kinds in which this "order book" and this "system of order numbers" can be organised, but that should be adapted to the conditions of the individual case.

Another very important question, however, arises straightaway —*i.e.*, can the production mainly be a delivery to stock and the goods then be despatched from stock to the customers, or is it necessary according to the nature of the customers' orders chiefly to produce these orders independently, and to despatch these separately produced goods to the customers without using a warehouse for finished goods? The first method will always be given preference in metallurgical works, as a great simplification of production results; but the question will always arise whether a warehouse will require such an investment of capital that the costs exceed the savings due to simpler organisation and easier production. It needs a very careful analysis of the received orders to find the correct answer; an analysis which has to take into account all variables contained in these orders, and their frequency. Observation of the orders over a fairly long time, and a statistical collection in various groups according to these variables, will be necessary in order to find out whether sufficient orders of equal or at least similar kind can be expected, so that a stock production can be recommended. In iron and steel works these variables will be, *inter alia*, quality and quantity of the raw material; quality, quantity and size of the finished goods; the type of finish and the tolerances required by different customers, etc. Very often—we may even say much too often—we will find

a multitude of varieties which alone seems to make a stock production impossible. Standardisation has not been sufficiently understood in the circle of the customers, and the supplier is afraid of the work connected with the education, or afraid of losing a customer, if he does not agree without argument to the demands of the customer, etc. This is not the place to discuss this question in more detail; but the unbiased observer must state, with regret, how large sums are lost by the lack of understanding between customer and supplier, so far as the question of standardisation is concerned, and that in spite of the deserving work of the British Standards Institution.

The solution mostly adopted is that of a mixed system: for some kinds of customers' orders a conversion into stock orders is made, *i.e.*, for all those for which that is possible without increasing inadmissibly the disadvantages of the warehouse, and the other part of the customers' orders are treated as they are, *i.e.*, the customer's order is used unchanged as a works order. This decision complicates the organisation considerably, but that must be permitted if the final result is a decrease of costs, which can only be decided in specific cases.

Summarising the analysis of orders, this part of planning can be defined as the systematic conversion of customers' orders into works orders, as best suited to the capacity of the plant under present working conditions, without neglecting the demands of customers as to quality, quantity and date of delivery of the finished goods.

(*b*) Developing Works Orders. When the number of works orders on hand are thus known, and for each of these orders are also known all details as to quantity, quality, size, kind of finish, approximate date of delivery demanded, etc., then the sequence of these orders has to be determined, and for each order a detailed working plan, showing which processes the material has to pass through, by which operations each of these processes is composed, which part of the plant has to be prepared for each process or operation, what labour is requisite, which tools, special jigs or gauges are necessary, etc.: in a word, the planning man has to envisage the total procedure of production in all details and to take care that the material, the plant and all necessary auxiliaries are at hand at each stage. This should be put down in writing, and such a specification,

once established, can be used again when the same works order turns up. Gradually a collection of master-specifications will accumulate which will more and more facilitate the planning work, especially for repeat orders, most identical with those stock orders mentioned above. In the case of these repeat orders, it will be of great importance to investigate—maybe by special work and time studies—whether the most economical method of production has actually been chosen, where improvements are necessary, and how they are adopted, and with what results.

(*c*) Time and Work Studies. We touch here the next part of planning work, *i.e.*, work and time studies, about which nothing more may be added to what has been explained formerly. But it leads to the next and last part, " progressing," which is partly based on work and time studies.

(*d*) Progressing. As may be remembered, progressing is defined as forecasting the times for carrying out the plan for the work. When saying that time studies should be used, it may expressly be added that sometimes, especially in starting a planning system, it may not be necessary, or even not advisable, to carry out these studies in the elaborate manner necessary for production control purposes, or when aiming for an improvement of a special production process. In this case the work to be done is so great that it may be sufficiently accurate to use a more superficial method, because it would otherwise take too much time before any results could be obtained. That may be allowed in some cases, but it must be remembered that a more superficial method contains a certain danger, as wrong time figures can discredit the whole procedure. In any case, it needs a person well experienced in time study work, as well as in the special kind of production, to avoid such mistakes. Sometimes the time study method may even be replaced by statistics taken from past production, if one can be satisfied that the basic figures of such statistics, the first establishment of figures of time in the shops for wages and cost purposes, are accurate enough and that a fairly stable state of production has been obtained.

**3. Additional Remarks.** That may be sufficient to explain generally how " planning and progressing " should be carried out. Only two remarks may be added, although the second partly repeats in other words what has been said already; but

it is important enough to be strongly emphasised by this repetition.

When planning is divided as above into four parts, and these are dealt with one after another, that does not mean that this procedure should be followed up also in practice. This division is made mainly for the purpose of easier explanation. Really the four parts are so closely connected with each other, at least the last three, that they have to be considered, and often dealt with, simultaneously.

Further, planning needs, first of all, *patience*. It takes months, sometimes years, from the day when it is decided to introduce planning to the date when the first practical results can be obtained, at least if the workshops in question are concerned with a fairly complicated production of considerable output occupying a lot of workmen, and only in such cases should planning be considered at all. The staff must be increased to do the preparatory work and will remain greater than before, even when the planning procedure has been introduced. Even then it depends to a large extent on the perhaps unchangeable spirit of the staff and the workmen whether planning will be desirable and a final success ; a fine psychological understanding is necessary for the correct anticipation. Therefore the warning may be justified :—

Only the man who, after considering all these circumstances, is sure that planning will be a definite advantage in his case, who has the energy, persistence and patience to carry out this job to the very end against all difficulties which may arise, and probably will arise, in works grown up without using this modern method, should really undertake it. It is much better to leave it alone than to stop halfway, and so to " lose face " somewhat before his workpeople.

**4. An Example of Successful Planning in practice at a Rod and Bar Mill.** It may be that this general discussion of planning and progressing produces a too academic impression on the reader ; he may say : " That sounds all very well on paper, but are there really such planning systems working reliably and with obvious success ? " Therefore it seems worth while to give at least one example in detail which confirms the general explanations. Of the abundant material one example is selected :—a rolling mill for steel rods and bars. It is perhaps superfluous, but it may be expressly pointed out that it is given here only as an example of how such planning *can* be carried out without recommending a perfect imitation even for a similar case. The system has already

been working for some years, but that does not imply that it should be accepted as typical in all details. Let us repeat that such a detail can be justified or criticised only with the full knowledge of the technical, economical and psychological conditions of the individual undertaking; of its development, its tradition, its geographical situation; and that everybody who disregards this fact should be considered as unfit for organising work.

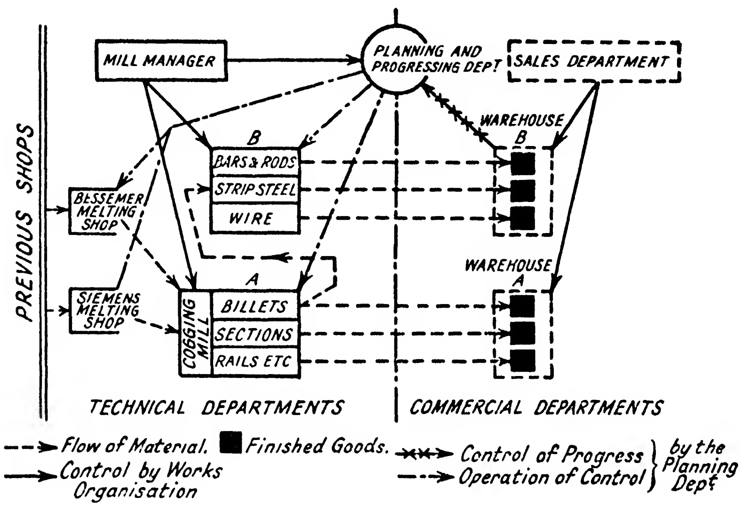



FIG. 51. Position of the planning and progressing department in the organisation of the works.

The position of the planning department in the organisation of the iron and steel works in question is illustrated by Fig. 51, which needs only few explanatory remarks.

The planning department in this case is only concerned with the production of the rolling mills B, and with the delivery of semi-finished goods (raw material) for the mills B from the mills A, not with the material delivered from it as finished goods to the customers *viâ* warehouse A. The mill manager is the direct superintendent of the planning department, which delivers to him all basic figures necessary for his managerial function, but depends in its work on relevant information from the commercial departments.

There are various influences on the planning work between

which a compromise must be sought in order to find the best solution. They can be divided into three groups :—

(1) Connected with customers' orders.
(2) Connected with production.
(3) Connected with the delivery of semi-finished products forming the raw material of the mills B.

Only the main problems may be mentioned under these three headings: (1) Quick delivery to the customer is important. This is best achieved by a sufficiently large stock; but the nature and composition of the customers' orders did not allow this to any considerable extent. Experience had shown that the same size could be rolled, as a rule, only at three weeks' intervals. It was, therefore, necessary to roll similar dimensions of such orders which arrived just before setting the suitable rolls, or during the rolling itself. The planning system must therefore be flexible, and sudden changes and interpositions must be possible without trouble. Thus, the rolling programme could be set up accurately only from day to day.

(2) For the changing of the rolls, the lower limit is the need to meet customers' requirements, the upper limit being the wear of the rolls. It has been found that the best sequence of the sections,

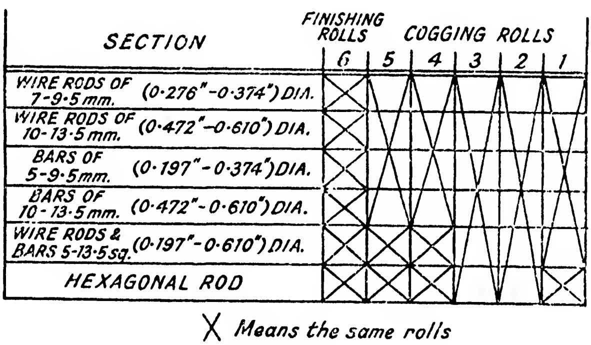



Fig. 52. Connection between the sections and rolls of a bar and rod mill.

and then the change of the rolls could be fixed, as shown in Fig. 52, for the rod and bar mill. Further factors which had to be taken into account were the manning of the mills and the consumption of gas and power; but even after fixing the rolling programme according to all these conditions, the mill manager was given the right and responsibility of changing the programme if he thought

it would be more economical in a special case. Usually, however, the programme as given by the planning department was binding.

(3) In order to have at hand the necessary semi-finished products at the right moment, and in the right quantity, investigations had been made to find the increase of the quantity of material during the previous steps of production (*e.g.*, Fig. 53),

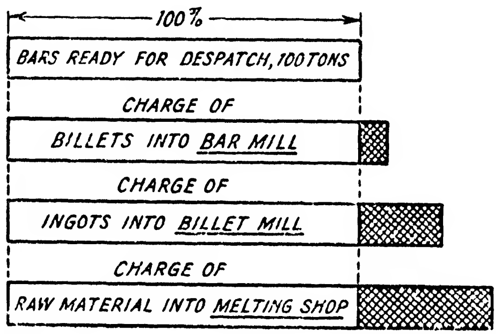



FIG. 53. Increase in the quantity of material during the previous steps when producing bar.

and the best production times in the melting shops have been determined as follows :—

(*a*) Ordinary steel produced by the Bessemer melting shops :—

| | Hours. |
|---|---|
| Blowing of the melt .. .. .. .. | $\frac{1}{2}$ |
| Casting and stripping (5 ingots) .. .. | $\frac{1}{2}$ |
| Heating in the soaking pit .. .. .. | 1 |
| Rolling billets .. .. .. .. | $\frac{1}{4}$ |
| Transport to mills B .. .. .. | $\frac{1}{2}$ |
| Total .. .. .. | $2\frac{3}{4}$ |

(*b*) Special steel produced by the Siemens melting shop :—

| | Hours. |
|---|---|
| Preparing the charge .. .. .. | 3 |
| In the furnace .. .. .. .. | 8 |
| Casting and stripping (16 ingots) .. .. | 1 |
| Heating in soaking pit .. .. .. | 2 |
| Rolling billets .. .. .. .. | 1 |
| Testing and inspecting .. .. .. | 2 |
| Transport to mills B .. .. .. | $\frac{1}{2}$ |
| Total .. .. .. | $17\frac{1}{2}$ |

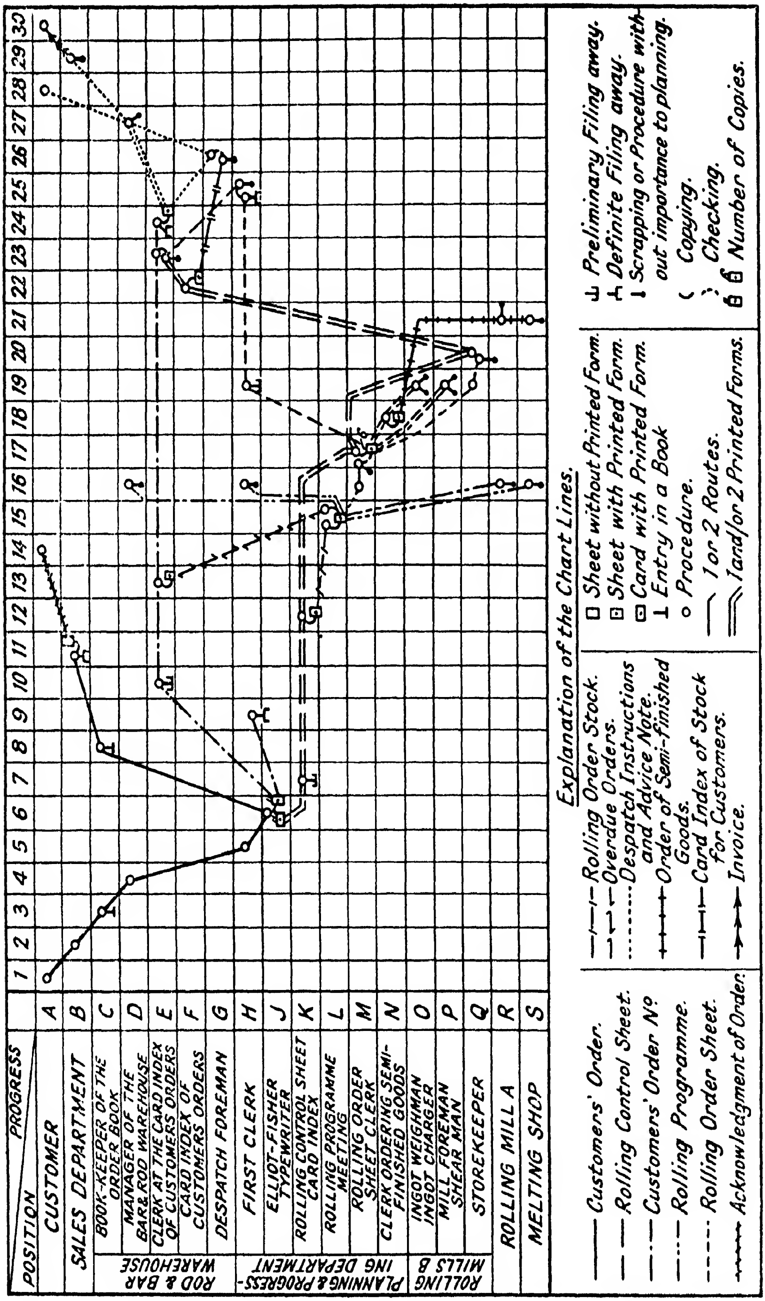



FIG. 54. Course of the planning and progressing organisation.

*(For key to Numbers see opposite page.)*

## KEY TO FIG. 54.

1. Despatch of the order by the customer.
2. Checking the customer's order as far as sales conditions are concerned.
3. Entry in the order book, work order number.
4. Determination of the approximate date of delivery.
5. Examination in the planning department.
6. Transfer to rolling control—and customer's order sheet.
7. Putting the rolling control sheet into a card index.
8. Ticking off in the order book.
9. Filing away of the customer's order sheet (planning departments' copy).
10. Putting the customer's order sheet into the card index of the warehouse B (bars and rods).
11. Writing and despatching the acknowledgement of the customer's orders.
12. Drawing up the stock of rolling orders.
13. Making up the overdue position.
14. Entry of the acknowledgement of the order at the customer.
15. Drawing up the weekly rolling programme.
16. Distribution of the duplicated rolling programme.
17. Writing the rolling order sheet.
18. Order of the semi-finished products (raw material for the rolling mills B).
19. Despatching the rolling order sheets to the shops before rolling.
20. Entering the weight into the rolling control sheet.
21. Arrival of the order of semi-finished products at works A and the melting shop.
22. Transfer from the rolling control sheet to the card index of the customer's stock.
23. Transfer from the rolling control sheet to the customer's order sheet.
24. Writing the despatch instruction and the advice note.
25. Transfer from the rolling control sheet to the rolling order sheet in the planning department.
26. Despatch and putting down of the weight by the railway company.
27. Transfer of the weight on the advice note and the invoice draught.
28. Arrival of the advice note at the customer.
29. Writing the invoice.
30. Arrival of the invoice at the customer.

These figures have been used to find again the right compromise between times too short for the supply of semi-finished goods, endangering the continuous working of mills B, and unduly long times with the disadvantages of an unnecessarily big stock.

The *course of the organisation* is illustrated by Fig. 54, to which only such remarks may be added which are not self-evident.

The *customer's order sheet* (see Fig. 55) changes the various forms of the customer's orders into a unit form, with all instructions necessary for production, delivery and control of the order. Under " special instructions " are given tolerances, details of bundling, signification by colour, tests wanted, etc.

This customer's order sheet is written on an Elliot-Fisher typewriter, where the paper lies on a plain metal plate, over which the typewriter is moved along. The rolling control sheet (see later) the most important link of the organisation, is laid above the customer's order sheet during the writing, therefore making a copy. Thus it is possible to replace quickly the rolling control sheets, of which each takes only one position—*i.e.*, one line of the customer's order sheet.

The customer's order sheet is written in two copies. One goes to the warehouse. This sheet has a division on the lower right part for entering the finished production as reported by the rolling control sheet. If a dimension has to be treated in the finishing bank, a twofold report is necessary, the first showing the rolled quantity, and the second the quantity without defects and ready for despatch. In this case the first report is entered under " finishing bank," the second under " warehouse," which otherwise takes the rolling report direct.

The customer's order sheet, by daily entry, shows accurately the state of the order and the progress of the work. Attention is drawn to overdue parts by omissions of entry, and these are collected weekly for the new rolling plan. The other copy of the customer's order sheet is retained in the planning department for reference purposes, and only dealt with again in case of changes.

The *rolling control sheet* (see Fig. 56) is prepared in two copies, together with the customer's order sheet, the printed form being the same as that of the lower left part of the customer's order sheet. As already mentioned, it takes always only *one* stage of the order. The steel quality is marked by the colour of the

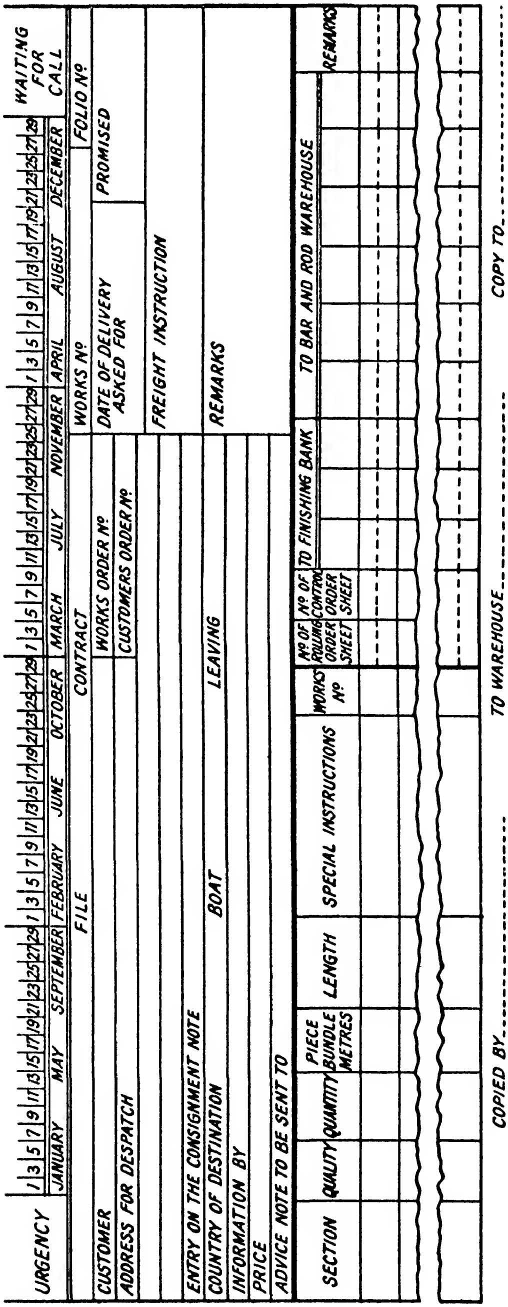



Fig. 55. The customer's order sheet.

rolling order sheet : Bessemer steel = white ; Siemens steel = green ; special steel = red.

The date of delivery is on the upper edge, thereby it is easier

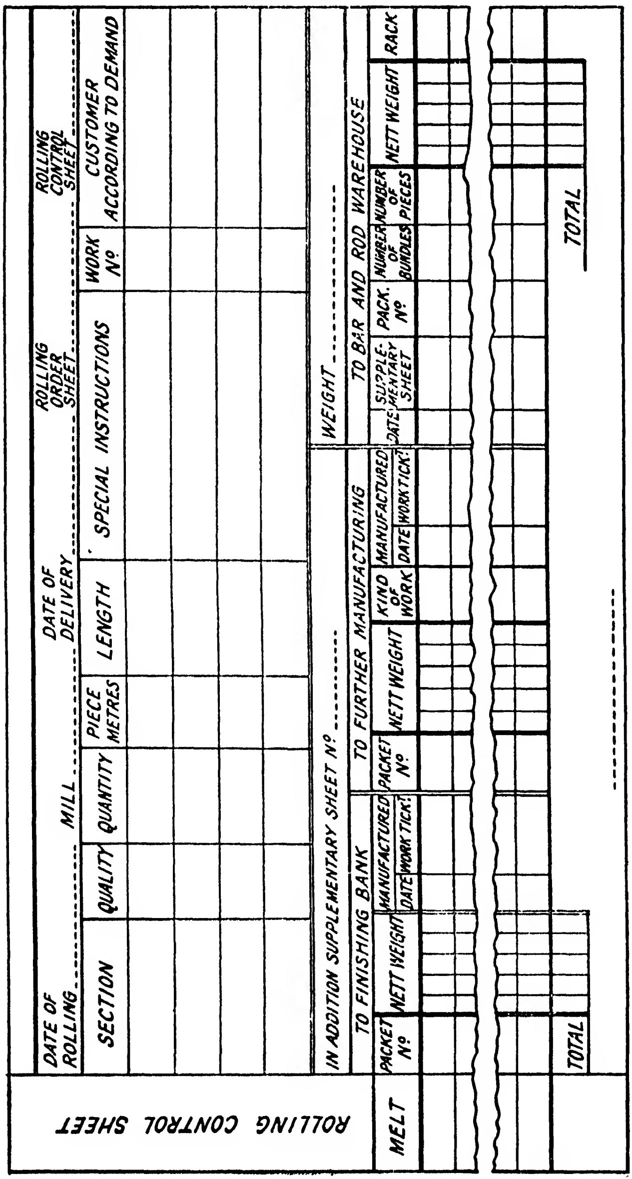



FIG. 56. The rolling control sheet.

to determine the volume of orders for the present and the following month.

The rolling control sheets are first put into a box allocated according to the various sections. Thus it is possible to have together in one batch all orders of one section or for one roll, if more than one profile is cut into the same roll, and to make up the one after the other in the same sequence as the rolling shall take place. The whole order stock is taken on Wednesday of each week for each section separately. The result is entered on a sheet which contains already the shift output—*i.e.*, capacity of the mill for the section in question—thus making it possible to calculate the loading of the mill in shifts.

For the preparation of *the rolling programme* a printed form is used, divided into six parallel columns, representing the six mills of the rod and bar mill; each is again sub-divided into columns for the individual sections, for Bessemer- and Siemens-steel separately. On the right edge of the form a further column is provided for summing-up the output of all mills together, again separated into Bessemer and Siemens steel. Thus an analysis of the rolling plan of the mills is obtained. The form is further divided, from top to bottom into the days of the week, and each day into three shifts. The back of the sheet shows in similar form the preliminary rolling programme of the next week.

The managers of the warehouses, of the planning department, of the rolling mills and of the melting shops have a programme meeting each Thursday, using as basis the stock of rolling orders and the list of overdue parts in progress. The warehouse can then give accurate dates of delivery, the mills B can determine the manning and the rolls to be used, and the previous shops can harmonise their production to the demands of the mills B. The rolling programme is duplicated and distributed to all places concerned (see Fig. 54—D.16; H.16; M.16; R.16; S.16). Frequently, necessary changes—even if small ones—of the rolling programme are agreed upon by the mills B and the warehouse together, daily at 9.30 a.m. for the next five shifts, starting with the afternoon shift of the same day. This final daily programme is passed on as instructions to the individual mills.

The *rolling order sheet* shows on the upper edge the section, the mill and the date, the number of the order and the number of the sheet; the left part has the same form as the customer's

order sheet and rolling control sheet, but enlarged by columns for the cast number, the number of the rolling control sheet, and the weight of the section per metre ; this is used for the calculation of the charge. The numbers of the control sheet begin for each rolling order sheet with 1 and continue in sequence. This number and the number of the rolling order sheet are transferred to the rolling control sheet, thus filing both forms close to each other. The numbers of the charges begin likewise with 1 and continue in sequence, one number of the charges sometimes containing several numbers of the rolling control sheets.

The calculated charge for one or several processes is entered on the right lower part of the roll order sheet, where a division is provided for all necessary figures as—number of melt, quality, section and length of billet, weight of piece and total weight, storage place.

If it is clear from the rolling programme that a certain section shall be rolled, the corresponding control sheets are taken from the card index and transferred to the rolling order sheet in the sequence of rolling (Fig. 54, M.16). Thus it is made impossible for a shift to pick out the most favourable components in order to get a high production in weight, but perhaps neglecting more urgent work in progress.

The sequence is : strips from wide to narrow, bars from small to large dimensions, as far as the same rolls can be used. Special steels are inserted always at the end of a piece or group of the same dimension.

The rolling order sheet is made as an original and five copies ; one copy being retained at the planning department (H.19). On this copy the rolled quantities are entered as soon as the control sheet has been returned with the correct weight from the mill, showing that the rolling has been carried out (H.25). The other copies are sent to the mills ; one to the ingot-weighman, who prepares the charge, the second to the charger at the furnace (O.19). On these two copies only the right part, concerning the charge, is filled. The third copy is received by the mill foreman, the fourth by the shearman, as instruction of the length to be cut, and the fifth and last copy is delivered to the storekeeper (Q.19). He weighs the various items of the finished products and stacks them, so that all items, even if arising from different orders of the same customer and being finished at different times, are

collected at one and the same place. All rolling control sheets, together with the rolling order sheet, are delivered to this storekeeper, who enters the finished weight and sends them as a rolling report *via* storage card index of the customer (F.22) to the warehouse (E.23) and the planning and progressing department (H.25).

The *order sheet for semi-finished products* (Fig. 57) is used for Bessemer steel which is not in stock at the mills A. The right part of this sheet is varied according to where the copy must be sent. Copies remaining in the planning department, or to be issued to the billet store, have columns for the three shifts of one day, and deliveries which could not be carried out as planned are transported to the order sheet of the next day. The other copies are used for planning and accounting purposes of the mills A and of the melting shops. As the orders of Siemens steel must be given at an earlier date, they are mostly "orders awaiting call." As soon as it is certain which casts will be necessary for the next time, an order is made up in five copies, one remaining at the planning department, the others to be issued to the mills A. There they are used as information of the planning department; the first by the Siemens melting shop for the analysis; the second by the billet mill for the heating time of the ingots in the soaking pits and the quantity, section and lengths of the billets; the third by the shearman for the quantity of the cut material

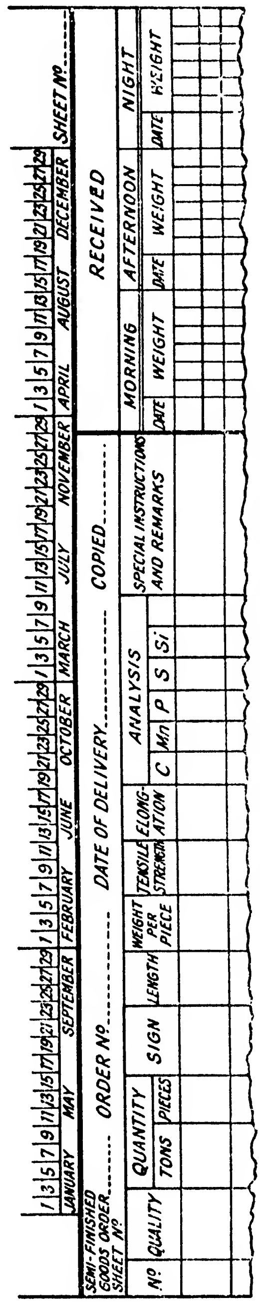



Fig. 57. The order sheet for semi-finished products.

and the number of the waggon transporting the material to the mills B; and the fourth by an inspector for the result of his inspection.

The clerical work connected with the *despatch* is based on the rolling control sheet. Fig. 54 shows that two copies of this control sheet arrive finally at the customer's card index in the warehouse, giving a report of the finishing of the order (F.22). For each customer there is one card where the details of all finished orders are entered, *i.e.*, not only quantity, size, etc., but also bay and rack of storage. Thus a survey is obtained whether there is sufficient quantity at hand from all orders of the same customer to allow for the despatch of a full load. The two copies of the rolling control sheet are now separated, one is used for completing the customer's order sheet (E.23), the other for recording on the rolling order sheet (H.25); so that the one shows how far the individual order is finished, the other whether the work is properly carried out by the mills.

In case the rolled material has to be treated at the finishing bank, the route of the rolling control sheets is somewhat different.

The stock-keeper sends them to the finishing bank, where they are separated: The one sheet remains at the finishing bank during the whole time of treatment, the other goes *via* planning department to the warehouse, informing both that the order is rolled but not yet finished for despatch. A supplementary control sheet, made up in two copies at the finishing bank, informs the warehouse that the work is completed, and at the same time enables the planning department to issue an order for replacing rejects if necessary. It is now possible to make up the despatch instruction (E.24), the advice note (E.24 and A.28) and the invoice (B.29), but the weight given by the railway company and by the control sheets must first be compared and a difference, if in the limits of the weighing errors, be distributed in percentage to the individual stages of the order, taking the figure of the railway company as authoritative.

Even a superficial reading of this description of a successful planning and progressing system will show that this problem of organisation cannot easily be solved. Taking into account that it is a comparatively simple example, concerned with a production involving only few processes in sequence, and using only generally applied auxiliaries, such as the Elliot-Fisher typewriter, card

indexes, etc., the warning given above, not to engage in planning without being convinced of the final success in spite of all difficulties, may be fully justified.

On the other hand, there is no doubt at all but that great economic advantages can be obtained by introducing and applying this modern method in the right manner. Besides these advantages, which can be expressed in money, the psychological effect on the responsible manager should not be forgotten ; a man who has his works well in hand can feel well prepared against any future vicissitudes. He who has had this experience once will always tend to repeat it, if he should obtain a new position in another works, and should certainly not be deterred by the objection that this method would not suit the new kind of production. In answer to this remark, the author can say that he has never met in his long experience any kind of production where this objection has not been made in the beginning ; but it has always been proved wrong in the end.

Finally, it may be added—in order to prevent any wrong impression—that it is not always necessary to go so far in planning details as in the example given above. That depends completely on the circumstances of the individual case, *i.e.*, the working conditions and especially the nature of the workmen concerned—a point of view sometimes overlooked, especially by outside organisers who are not familiar enough with the tradition of the firm. It is perhaps possible to work successfully and economically with a skeleton planning system, if the workmen are well trained and settled, while a more elaborate planning, such as shown in our example, is required when dealing with frequent changes in the manning. One thing however is certain ; some kind of planning must and does always exist, even if the management denies it, as one finds sometimes in old-fashioned works : in this case one can be sure that it is done, perhaps in a very primitive manner, by the foreman concerned, and it is probable that he does it with the best intention and according to his best ability, but certainly less efficiently than a man who is specially trained and can devote his whole working time to this job, which must be always a sideline for the foreman concerned.

**5. Carrying out Budgeting.** When looking back over what has been explained about planning as a whole and considering that the budgeting of a workshop or department is nothing else but

expressing the probable consumption of material, working time and other expenditures of the department in money figures, it will be obvious that this budgeting is simple when based on the figures given by planning. From these the degree of activity can be calculated (provided, of course, that the capacity of the department and of its plant, machines, work places, etc., is known), and it is then possible to stipulate beforehand the amount of expenditure allowed for the individual types of costs, taking the standard cost figures as basis and deriving the figures for the degree of activity in the manner described earlier in this book. Thus the budgets of the departments can be developed in all details, and works are known which have arranged for delivering such budgets to each department for a future period, a week or a month, and are in the habit of proving later whether and where the actual figures of the past period differ from these budgets and why. There is no question that this is a very strong control of expenditure and that it tends toward economical working throughout the works. But the necessary supposition is that the budget figures are correct, *i.e.*, adapted to the actual conditions of work, and that they are used in the right manner: they can never be considered as prescriptions or even commands; they can and should be only "signposts" showing an approximate amount. No blame attaches to anybody who exceeds or undercuts these figures unless mistakes or omissions are shown by special investigation.

In these circumstances the question arises whether the system of budgeting as characterised above and sometimes praised as the highest development of cost-accountancy must not be considered as an exaggeration of an idea sound in itself. The author remembers various cases where the considerable clerical work connected with this arrangement was partly wasted by the fact that the comparison of the actual and stipulated costs was carried out either not at all or too late, or that the correct conclusions have not been drawn from the differences discovered, or that the executives in the shops tried by all means, even on the cost of economy, to obtain a coincidence of the two figures, etc. These words should not be taken as a warning against the idea of budgeting, but only against the wrong application of it; it would often be better to keep back these figures from the shops and to use them only for office purposes, *i.e.*, for developing the

production-, sales-, or finance-budget instead of using them in the works' departments. That at least is the author's experience. But as already mentioned, these figures are indispensable for developing the budget of the whole undertaking and of its functions, at least if one likes to have some surety that these budgets correspond sufficiently to reality. If the departmental budgets are at hand, it is only a matter of changed grouping of the figures—roughly speaking from cost positions to types of costs—to obtain the budgets of the individual functions; and their correct composition leads to the budget of the whole works. This is done monthly or quarterly and the result is an important basis for the business policy of the management during the next month or quarter of a year. Obviously correctness of the figures is desirable; but here is again the place where a warning is necessary against too high accuracy. Budgeting is a kind of prophecy, and as nobody can anticipate correctly what the future will bring it is bound to contain uncertainty and surprises. It is therefore often not worth while to carry out wide investigations for making sure that this or that figure is correct; it is in many cases much better to rely on the instinctive feeling which generally develops in a man who has to build up these budgets period after period. That shows again that this job is no routine, but needs a man of a clear mind with a good survey of the whole undertaking and its working conditions and with full knowledge of the costing system and of the results of the work of the costing department.

## B. ESTIMATING

It has already been mentioned that another branch of industrial accounts where standard costs may be used advantageously is the estimating of costs which may arise in future; either to find out the profitableness of new methods of production, new plant, machinery, etc., in which case the investigation comes out more or less to a comparison of costs, or to establish a price for tender purposes.

**1. Comparison of Costs.**[1] This much-discussed topic has been treated here rather concisely, as otherwise much would be repeated that has been mentioned elsewhere, but it is necessary to recall some general remarks to the readers as otherwise the

[1] See *The Machinist*, vol. 84, p. 518E and p. 467E.

connection would have been interrupted and the understanding rendered more difficult. Also some examples have been inserted for introducing the reader more impressively into the spirit in which this work should be done.

(*a*) Various Types of Comparison of Costs. The object of comparison may be (1) a process, (2) a workshop or department of the works or the whole works (in other words, a uniform production), and (3) a single undertaking or a combine composed of different works, in each instance a financial whole being formed. In all three cases comparison may be made either between the same objects at different times, when one may perhaps speak of "internal" comparisons as only figures of one and the same combine or works are used, or of different, but to some extent similar and therefore comparable, objects in various works at the same time, when the term "external" comparisons could be applied. Thus six types of comparison would be possible in theory, but there are so many similar or equal features that it will not be necessary to consider each type separately with the same accuracy.

The most important supposition for making possible a comparison is that the figures collected in the two cases to be compared are built up on the same basis. That means a standardisation of notions, which is comparably easy for internal comparisons, but connected with many difficulties for external ones. Nevertheless, such standardisation is absolutely necessary and should be carried out before the collection of figures is started. It is sometimes attempted to do that afterwards, *i.e.*, to make the figures obtained comparable by remodelling them according to common definitions. This has mostly given results which could not be trusted as the errors always connected with such transformations may be greater than the differences between the figures to be compared.

Furthermore, before a comparison is made, it has to be decided which part of the cost figures must be taken into account, as generally it is not necessary to regard a whole group of figures of which a considerable part may remain unchanged. How far to go in this direction depends entirely on the purpose of the comparison. It cannot be decided in general terms, but when thus separating the variable figures from the total in order to facilitate the work of comparison, the final result must be related

again to the total, especially if, as in most instances, the difference is to be expressed as a percentage.

On the other hand, the demand for standardisation can be pressed too far, *e.g.*, when comparing works of the same size, or at the same degree of activity, or in the same state of mechanisation, etc., should be made compulsory. There are often just these differences, the influence of which should be found out by the comparison.

These notes may seem perhaps so obvious as to be superfluous. Experience has shown that that is unfortunately not the case. They show, on the other hand, that the comparison of costs needs a careful and experienced hand and that anything like a scheme to work is impossible.

(*b*) Comparison of Processes. The term "process" should be understood in its largest sense. It may be that this procedure is used in the production shops, main or auxiliary, but it may also be that it is applied to the supply of material, to the administration or to the sales and distribution. For example, it is questionable whether some material should be supplied from a wholesaler or from a co-operative society. The prices per unit are, we assume, the same in the two cases, but the easier supply in the second case makes it possible to keep a smaller stock, the interest is lower, and a dividend of the society can be considered as a further decrease in purchasing costs. In one instance, calculation proved that the profit made without regard to the costs of purchasing was 7%, decreased in the first case to 6·2 and increased in the second to 10·1, thus confirming the old and often repeated but not always sufficiently considered principle: "What has been saved in the buying does not need to be earned by production or selling."

The method of comparison should be applied more than is usual in practice to the introduction of office machines. While production machines are always bought only after careful consideration of profit that can be obtained, that is rarely the case with office appliances, which afterwards very often can be found idle, because they are difficult to use or of no real advantage to the case in question.

The important problem, already touched on when planning was discussed generally, whether the sale shall be from a stock of finished goods or directly from production against a special order

or by mixing these two arrangements can be decided on calculation of the costs in the different cases.

One of the most discussed questions in production is the size of the batches in which a given workpiece or a quantity of special material should be produced. A detailed and careful cost comparison showed in a particular case that the production costs went down as shown below, the first production of the workpiece in question being taken as 100.

| | | |
|---|---|---|
| Single new production | .. .. .. .. | 100.0 |
| Repeated single production | .. .. .. | 50·0 |
| Usual batch production 3 pieces | .. .. .. | 38·7 |
| ,, ,, ,, 10 ,, | .. .. .. | 29·8 |
| ,, ,, ,, 15 ,, | .. .. .. | 28·7 |
| ,, ,, ,, 30 ,, | .. .. .. | 27·7 |
| ,, ,, ,, 60 ,, | .. .. .. | 27·6 |
| Alternative production on continuous belt | .. | 23·2 |
| Steady production on continuous belt | .. .. | 21·5 |

All these comparisons, of course, give only *one* indication as to the decision to be taken in the special case. It may well be that the man finally responsible for the result of the business will disregard the figures and decide contrary to them, owing to some consideration which cannot be expressed in money figures ; but if he does, at least he knows what loss of money or what decrease in profit is involved in his decision.

(*c*) COMPARISON OF PRODUCTIONS. When comparing the costs of several productions it is necessary to distinguish clearly which of the three points of view, types, positions or bearers of costs, should be taken as basis, and the method of comparison will vary correspondingly. First of all, however, it is necessary to remember that the costs for any production are not an absolute figure, fixed once and for all ; they may change for many reasons, even at the same place for the same product and the same type. These reasons may be a change in the design of the product, even if it is not shown in the shape of the finished goods, a change in process of production, a change in the composition of orders to be carried out, a change in the organisation, and especially a change of the degree of activity. These changes must be eliminated because a just comparison can take place only by " comparing equal with equal," but this elimination should stop short of obscuring

differences which take place independently of the changing working conditions the discovery of which is just the object of the comparison.

Thus it may perhaps be that the influence of the degree of activity on costs is to be eliminated. Then it is best to base the comparison on "standard costs." In another case it may just be the influence of the changing degree of activity which is to be discovered. This problem has been dealt with sufficiently at a previous opportunity, but an example may give a further illustration.

An electric works driven by water turbines had a capacity of 10,000 kwh. and the total cost of the plant was £250,000. With depreciation at £11,750 and salaries and wages at £1,750 per annum, the fixed costs can be taken as £13,500, while the proportional costs amount to £2,350, giving total costs at full activity of £15,850. As $365 \times 24 \times 10{,}000$ kwh. can be produced per year,

| | | | |
|---|---|---|---|
| Proportional costs per unit are | | | 0·0648d/kwh. |
| Fixed | ,, | ,, | 0·3700d/kwh. |
| Total | ,, | ,, | 0·4348d/kwh. |

If the degree of activity is only 75% the costs change into $£13{,}500 + (2{,}350 \times 0{\cdot}75) = £15{,}310$, and the production into $0{\cdot}75 \times 365 \times 24 \times 10{,}000$ kwh.

| | | | |
|---|---|---|---|
| Proportional costs per unit are | | | 0·0648d/kwh. |
| Fixed | ,, | ,, | 0·4930d/kwh. |
| Total | ,, | ,, | 0·5578d/kwh. |

*i.e.*, 28·3% higher than before.

Some people prefer to calculate the proportional costs per unit as explained, but to relate the fixed costs always to full capacity, giving as reason that the production management cannot be made responsible for the majority of the fixed costs. The author does not agree with this view, which would mean that the total costs per unit hardly change when the degree of activity is changing. In order to satisfy the standpoint of the defenders of this method of calculation it would be more reasonable to give the figures of the fixed and proportional costs per unit separated as shown in the example, and then to say that only the proportional costs should be taken as a characteristic of the work of the production manage-

ment. But even that cannot be considered very satisfactory, because it is a wrong point of view to make a comparison of costs in order to condemn or to acknowledge the work of a person concerned. One wants rather to obtain a better knowledge of the connections of the facts governing production in order to come to improved results in future.

Another example comes back to the author's mind, a very interesting investigation which he had to deal with a long time ago —as a matter of fact before the 1914–18 war. It was the very case of a comparison of production costs, all external circumstances being as favourable as possible for such an investigation ; and yet how difficult was the work and how small the final result, in spite of the efforts of all concerned to obtain a real success.

Three works, working independently, but financially united in a combine with pooled costs and profits, produced practically the same goods, bought in the overwhelming majority by only one customer, the railway company, which had nearly the monopoly in the country. The products were almost completely standardised by this customer. Detailed drawings with exact measures, tolerances, etc., and instructions as to the quality of materials to be used, were at hand and yet the costs of the products originating from the three different works varied considerably from one to another and—what was more astonishing—irregularly with regard to their origin.

A careful investigation brought to light some of the reasons for these differences which were based on the various localities, structures and manning of the three works. The first was highly mechanised, part of a combine where mass production was the outspoken purpose of production ; it was situated near a large city and its industrial centre, and had consequently a comparatively high turnover of labour, the workmen mostly being well trained in their jobs. The second works was near a town of middle size, also fairly mechanised but with a plant not completely up to date ; the workmen, accustomed to their workplace and mostly well skilled and willing, did not like to change their situations, and could be considered steady and lasting collaborators, although other industrial works were not too far away. Finally, the third works was in more agricultural environment. The men, accustomed to farming and gardening, were not too eager to do their job. They sometimes even stayed at home when

the work on the land or in the garden seemed to them more important, and the management, knowing it to be difficult to find substitutes quickly, was forced to overlook this irregularity.

When the investigation of the costs was started it was generally taken for granted that the lowest costs should be obtained in the first, and the highest in the third works, the second lying between both. For at that time it was believed that the fact expressed by the slogan : " Savings can be made only by increasing the overheads " had such an overwhelming importance that all other influences would disappear in comparison. This means in effect that the highest mechanised must always be the most economical works. Without denying the truth contained in this sentence, it is well known to-day that this truth, like every other, can be converted into the contrary by exaggeration.

When it was clear that the anticipated result could not be obtained regularly, the reason was found first in some differences of the costing system. Some wages were taken in one of the works as direct costs which could be distributed directly to the orders, or in one of the other works as part of the overheads, *e.g.*, increased payment of overtime. In one of the works the dissection of the expenses was driven much further than in the other, although the extreme case of a general all-round rate could not be stated in one of the works, even at that time nearly 30 years ago. (Considering that there were shops of hand work and machine work of various nature, this all-round rate would certainly have given wrong costs of products with different proportions of hand and machine work.)

It became then clear in the course of this investigation that some standardisation of the costing system was necessary to eliminate discrepancies between the calculations which originated from the different costing methods. But even when this work was carried through and the comparison of costs was started again, differences of absolutely irregular character remained and it was impossible to explain their reasons. Soon afterwards the war broke out and prevented continuation of the investigation.

The author is inclined to-day to blame the existing piecework wages at least for the greater part of the inexplicable irregularities. At that time the principles of fixing fair piecework wages were not yet known sufficiently. It was more or less a bargaining between foreman and workman with all the well-known imperfections of

this method of stipulating a piecework price. If this example has been discussed more in detail that has been done because it offered such an opportunity to illustrate how many and various aspects should be taken into account when comparing production costs.

Similar considerations should apply nearly always, and almost every case has its particular features which can and must be taken into account. The difficulties are great but they are not unsurmountable as long as "internal" comparisons are considered, *i.e.*, those within the same works or at least within the same combine. Whether it is possible to make fair "external" comparisons of production, as one finds so often in national economics papers, is very doubtful so long as no extensive preparatory work has been done by some institution of scientific or economical character, as the Institute of Costs and Works Accountants, the Institution of Production Engineers, employers' federations, etc. In any case, all results of such considerations should be used with the utmost caution as long as one cannot be sure that the suppositions in the cases compared are sufficiently equal.

(*d*) Comparison of Undertakings. The object of comparison may be in this case (1) the profitableness, (2) the realisation of the invested value, and (3) the balance. At a first glance it seems to be obvious that the published balance sheets and profit and loss accounts should be taken as bases of comparison, but anyone who knows how these statements are usually developed from the internal figures of accountancy will agree that it is very doubtful whether a fair comparison is possible by this method. At least the "internal" balance sheets and profit and loss accounts should be used, *i.e.*, those which are not yet "purified" and "shortened" for publication purposes, with concealed reserves, accounts drawn together, etc. And who, wanting to make external comparisons, will have at hand these internal figures? It is even difficult to collect them in a combine so that a faithful picture of the facts can be obtained. Unfortunately, that spirit is not yet quite dead which an old veteran of cost accountancy characterised in a confidential conversation 30 years ago by the complaint: "It is the tragedy of my life, that I wanted to give them 100% of the truth, but they allowed me only 60%, and sometimes even only 40%." For the rest a hint may

be sufficient of the discussion in Part I, Accountancy, under the heading, Management ratios.

These considerations on comparisons of costs try to show the difficulties implied in the problem and the mistakes too often made, but if a reader should draw the conclusion that comparison of costs should be abandoned completely as the result will always be doubtful because of these difficulties and possible mistakes, the author will have been misunderstood. It may therefore be emphasised expressly that there is no question whatsoever about the usefulness of such comparisons, if carried out correctly ; but the difficulties are mostly underestimated, many reasons for errors and mistakes are only too often overlooked, and then conclusions are drawn from the obtained figures which are obviously wrong. The object of this discussion is to draw attention to this fact, but not to deter anyone from doing the work. Difficulties are there, it is well known, to be overcome, not to repulse.

**2. Estimating for Tender Purposes.** Mention of estimating for tender purposes as one of the applications of standard costs can be brief—partly because this work is not so important in iron and steel works as in machine shops and factories concerned with more finished goods where large staffs are commonly engaged on nothing else—but principally because the process of estimating for tenders has already been explained although not expressly mentioned. Supposing an inquiry is received from a customer about goods the price of which is not fixed by an agreement between the members of the employers' federation (a case which will be comparatively rare) one has only to use the general equations of cost calculation as developed in Chapter XII of this book and apply standard costs to all figures of raw material, wages and other expenditure necessary in the case in question. As far as the margin is concerned between the total costs and the selling price the considerations with regard to the obtainable and the acceptable price must be used as a guide. That is about all that can be said generally, and it does not seem to be necessary to give any examples as these can be taken from what has been explained at former occasions.

# PART V

# THE ORGANISATION OF ECONOMIC CONTROL

## CHAPTER XVIII

# PRELIMINARY REMARKS

Looking back over the first four parts of this book and considering in broad lines what they contain on the essence of economic control, the reader will certainly ask how this widespread work, this important service piercing through all departments of the whole undertaking should best be organised.

Of course, if this problem is not discussed to some extent and some guidance given, the book would remain a "torso" and its practical value could be impaired. On the other hand, attention has more than once been drawn to the character of organisation as a science, or rather an art, designed to adapt the necessary measures to the conditions of the special case. Someone has expressed this fact by his answer when asked for the principles of organisation: "There are none; a good organiser must be a man without principles." That may be an exaggeration, but there is some truth in it and this makes it difficult to write or speak generally on organisation problems.

Thus when reading the following discourse it should be borne in mind that besides being incomplete it may even give advice which is inappropriate to a particular case. The sole aim of it is how in the author's opinion the present frequently unsatisfactory state of affairs can be efficiently improved.

We know that economic working in an industrial concern means the achievement of the purposes of this concern, producing and selling certain goods by the simplest and cheapest methods just compatible with the quality of these goods as demanded by the customer. And economic control is nothing else but proving how far this end has been attained and where it has not, why not. The obvious consequence of the knowledge thus acquired should be an improved working in future, again proved by economic control.

How can the simplest, cheapest and, nevertheless, appropriate

methods of working be found out ? Best by an intensive research work divided into three kinds of studies :—

Organisation-studies,
Work- and time-studies, and
Costing-studies,

and these are therefore the three pillars on which economic control can be developed.

The reader of this book no longer needs an explanation of the close connection, the intimate links even between these three kinds of studies. The whole contents of the first four parts show that with sufficient clearness, and if one or other of these studies has been discussed in isolation, that has been done for easier understanding only, but not without the express reminder that this separation is impossible or at least hindering in practical cases.

How is the state of affairs with regard to this research work at present in practice ? Generally costing-studies are carried out by the costing department ; where work- and time-studies are made they are mostly the duty of a special department with the unsuitable name : efficiency department, and real organisation studies are very rare, but if they are undertaken it is usually also by the efficiency department.

Whether this is the best manner to deal with this problem will not be discussed for the moment ; that will be done later after the description of the typical present state of affairs has been finished, *i.e.*, the organisation of the costing department and of the efficiency department have been considered as they are to-day —or at least as they should be as long as they are working parallel to each other.

CHAPTER XIX

# THE ORGANISATION OF THE COSTING DEPARTMENT

An attempt here to describe the organisation of what is called in the heading of this section according to the shop language, "costing department," but is actually the domain of "industrial accounts" (see Fig. 1) is not to be taken as an exhaustive explanation of a "special system" with all printed forms and their course through the offices concerned. For this purpose the reader would do better to rely on the special literature on accountancy and costing. It is rather the drawing of conclusions from the discussions in the former parts of this book and the developing of a guide to the practice in principle of such an organisation. If thereby some ideas are repeated which have already been discussed in detail, the reader will understand that this has been done in order to maintain the necessary connection.

## A. CONNECTION OF THE COSTING DEPARTMENT WITH OTHER OFFICES OF THE WORKS

Whilst the costing department is mostly a supplier with regard to other offices, delivering useful services without which no proper economic control would be possible, there are also some departments on whose help the costing department relies and cannot work properly if this help is not given sufficiently, correctly and at the right time. These are mainly the stores, the wages office and the invoice department, the last denoting the two often separated offices for controlling suppliers' invoices and for making out customers' invoices. The vouchers coming from these departments as material requisitions, wages tickets, invoice copies, etc., are the basis on which the whole work of the costing department is built up, and it cannot be too often emphasised that these vouchers should not only be carefully developed as far as their printed forms and the course through the interested departments are concerned, but first of all correctly filled in and controlled as to this correctness. Only one who has been responsible himself

can perhaps imagine what a difficult and thankless job it often is, how again and again correction is needed of the same mistakes let slid by foremen and workers out of carelessness, but sometimes also to avoid too accurate a control, and by junior clerks and office girls through lack of understanding. The clearer and more concise the forms, the more easily will these mistakes be eliminated, and although a desire to limit the number of these printed forms is understandable, such limitation should not be carried to the point of endangering clarity in the instructions. The often proposed remedy to get rid of the help of foremen and workers completely by introducing special clerical staff for this job is certainly excellent, but costly ; and in iron and steel works with some jobs of the men of very short duration not always practicable. Still a method recommended in many cases is to distribute over the whole works persons or even small offices composed of clerical staff members (some of whom at least should understand technical processes) to be responsible for this job ; but one has to be careful that by doing this and thus eliminating one difficulty (*i.e.*, that arising from incorrect wages tickets or material requisitions) another difficulty should not be brought about by the somewhat doubtful subordination of these "works offices." This remark touches a very delicate spot in the organisation of many works, not only in the iron and steel industry, but in industry as a whole. The author has found that in this problem also there is no universal remedy. The answer depends too much on the size, the layout, the tradition of the works, etc., and especially on the individuality of the persons concerned. If the author is to give a general advice from his own experience, he can only say : the larger the size and the area of the works, the more the individual production departments can work independently of each other, and the more the departmental managers approach the modern type which declines to be a pure producer, but is interested also in matters of organisation and economic control, the more reasons speak for a subordination of these works offices to the departmental manager concerned. It should, however, not be forgotten that this measure may bring forth the danger of splitting the organisation of the works into as many independent parts as there are departments and so losing the connection between them. This must, of course, be prevented in any case, as experience shows that this state of affairs only too often develops into working of

the individual parts against each other. The best expedient is to create the position of an organising superintendent whose duty it is to care for the uniformity of organisation as far as this is possible without hampering the work, and to adapt the individual measures of organisation to the peculiarities of the special cases. This superintendent, who is responsible directly to the general manager or the managing director, is working solely as a consultant; he has not the right to give orders himself, but can do it through the departmental manager concerned throughout the whole works, and if by virtue of his knowledge, experience and especially his personality he is the right man, his influence can be very beneficial.

With this problem as with all questionable matters of organisation, each solution has its drawbacks and its advantages and organising skill is nothing else but tacking between both in order to find the least restricted way.

## B. THE WORK IN THE COSTING DEPARTMENT ITSELF

The work in the cost department itself falls into two parts of which unfortunately only one is usually considered when planning this work beforehand, *i.e.*, the routine work, while the second part, the drawing of conclusions from the figures obtained by the routine work, and special investigations in order to answer particular questions by the management, are usually considered as casual jobs which can easily be done as additional work by forces in reserve as they may be available wherever the planning of work has been done with the necessary care. Now it is obviously foolish to get in such a position; for the very results of the routine work mostly say very little, if anything; it is the conclusions that can be drawn from them or built up on them that matter; and it is therefore probable that the above standpoint has not been chosen intentionally. There can, however, be no doubt that the result in practice is often such a one as just described. The manager of the costing department is then in the difficult position of being unable to satisfy the demands his " customers " are entitled to make, *i.e.*, to render to the other departments the services they rightly expect, because his staff is too small or at the best lacking the trained people necessary for this developing of results specially asked for by the management of the works. The correct way of improving this untenable state

of affairs is unfortunately taken comparatively rarely, *i.e.*, to explain the reason of the drawback openly to the management and to ask for the engagement of more or specially trained members of the departmental staff. Perhaps the man at the top of the costing department fears that such a request would be misunderstood as a reflection on his own ability; perhaps he himself has not succeeded in finding out the real reason of his difficulties; in any case he does not go to the root of the trouble, but in consequence of a single inquiry that caused a special investigation for one department, he develops a method to find out this or similar results for each period in a series of departments similar to the first and includes the originating work into the routine work of his department "in order to be always prepared to answer similar questions." It may be insignificant if that happens once only; but this happens repeatedly and finally the department is swollen to an apparatus which can no longer be tolerated; an investigation shows that an enormous number of results have been continuously elaborated which no one has asked for or made use of. The result is a crash, and one or more of the next-concerned lose their positions.

This story may be somewhat exaggerated, but it is certainly not too far from some events in practice. It is only too easily forgotten that the costing department is first of all a service to the other departments and the management; that each result it gives out may create a further inquiry which again requires special work apart from normal routine jobs, and so on, and that a certain part of the departmental staff must be reserved for the quick delivery of these answers.

## C. THE ROUTINE WORK OF THE COSTING DEPARTMENT

The development of the list of accounts or types of costs and of cost positions is an important part of the preparation of the cost department routine work. As already mentioned, both lists should be discussed in detail with the works and commercial managers and the departmental managers concerned before they are finally fixed. Care should be taken that organic changes in the structure of the works inevitable in the course of time are quickly reflected by alterations of these lists.

In accountancy the actual book-keeping according to the rules

of the double-entry method forms the most important part of the routine work resulting in the annual balance sheet and profit and loss account. It may be called to mind that if accountancy is carried out in the manner recommended the short-term (monthly) closing of books and balancing can be done with sufficient correctness and not much additional clerical work, thus showing the result of the past month perhaps on the 10th or 12th of the following month. The work can even be arranged so that the annual balance sheet and profit and loss account can be finished with little more work than the monthly ones.

The routine work of the section "works accounts" consists mainly in the distribution of the costs to the cost positions, the determination of the percentage additions representing the "actual" overheads and the development of the corresponding additions representing the "standard" overheads. Of course, the latter will not change from month to month, but be kept equal as long as possible; it is as well, however, to confirm them once a month, as experience has shown that such figures are easily kept too long unchanged and then no longer reflect the actual development of the working conditions in the works.

As for job accounts only standard costs should be used, the "post-calculation," *i.e.*, determination of costs of orders carried out, is limited to one job only for each object of production as long as the section "works accounts" reports that the standard costs have remained unchanged. The same applies, of course, to the "pre-calculation" or estimation of costs for tender purposes, where the routine work, if one can call it that, is certainly also made easier by the use of standard costs, but the reduction of the real work to be done is not so large as with the determination of costs of orders already carried out.

Finally, a few remarks may be added about the necessary statistics which are often considered as part of the routine work of the costing department.

Before starting any statistics it should be carefully investigated whether the figures that may result from this work are really needed by the management for decisions that may come round in the usual course of business. The manager of the costing department will seldom have the scope to settle this matter alone. A discussion in detail with the general, works and commercial managers and the departmental managers will be necessary, and

in these discussions references should be made to the essential statistics only. For there can be observed in practice an inclination to ask for all kinds of figures which are then provided for week after week and month after month without being used or even looked at. Similarly the distribution of statistics should be limited to those who by their work are actually interested in the special figures contained in these statistics. The reason for this demand is not any kind of secretiveness, but the wish to give to everybody responsible for a certain part of work as easy a survey as possible of his domain without disturbing him by an enormous quantity of figures which have no connection with his own job. The system of developing one general scheme for all the statistics to be carried out weekly or monthly and sent to prominent members of the management cannot be recommended. For works of the size as iron and steel works this leads to the formation of veritable booklets in which everybody has to hunt for the figures which interest him.

And again, nearly all these figures are insignificant when considered as absolute for an isolated week or month. They get a measuring only by comparison with the figures of earlier periods, and it is therefore usual to find in these reports not only the figures of the last week or month, but also the figures of the last but one and the average of the figures during the year in progress as well as during the last finished year. That, however, renders the reports still more bulky and difficult to survey. In order to avoid all these disadvantages it seems to be better to develop for each leading person entitled to the receipt of statistical figures special forms, spacious enough for a year, or at least a quarter of a year, into which the new figures can be entered week by week or month by month. Of course, one has almost to renounce thereby the use of all modern means of reproduction and to that extent clerical work will increase. In return one has the satisfaction that what is given to the leading persons is of direct use to them and will therefore be much more appreciated than the former reports which needed a special preparation before being of real use to the receiver.

Whether one should collect these figures in the form of tables or graphs is sometimes more or less a matter of taste, but sometimes one or other kind of representation is preferable. That depends not only on the object of the figures but also on the

personality of the manager to whose use the statistics are prepared. Human beings are—thank God—not yet "standardised," and while one understands graphs easily, another prefers tables. It will depend on the skill of the cost department's manager to satisfy as far as possible all personal wishes, whilst remembering that some uniformity is in the interest of the undertaking as a whole. Thus it has been found useful, for example, to collect the statistical figures into three groups, which can be equal in nearly all production departments, *i.e.*, figures concerning (1) working time expressed in hours or minutes, (2) output in quantities, weight or number of pieces and (3) costs in money. The opportunity may again be taken to point out how important figures of time and quantity are, and that they have in many cases the great advantage over money figures of not introducing the uncertainty and fluctuation of prices into a comparison of figures which, for comparison purposes, should rather be measured by a completely constant measure. It can well be understood that the accountant in consequence of his training thinks first of all in money; and at last when the economic result of the works has to be determined and analysed, this kind of measure cannot be avoided, as it serves as the common denominator of the value of the various goods, which can be changed into comparable figures only with the help of this evaluation; but the technician is accustomed by his training to think first of all of time and quantity, and as a great part of his customers are technicians this should be an additional reason for the accountant to the use of money as a measure as long as possible.

The exclusive use of standard costs in job accounts, as asked for in the detailed discussion about the relation between actual costs and standard costs renders unnecessary the production and sales statement in the form explained in Chapter XIV; for the percentage of profit on a certain product is known by comparing its standard costs with its selling price, and by summarising the invoices of a period according to the various goods sold, it is easy to determine the share which each of these goods has on the total profit.

## D. SUMMARY

Thus the routine work of the department is mainly restricted to:—

(1) Book-keeping in accountancy with the monthly closing of books for short-term balance sheet and profit and loss account ;

(2) Statistics of working time, output and costs for each production department or cost position and in the case of costs showing actual costs in comparison with standard costs.

(3) Statistics of sold goods put in order of types of goods, districts of selling agents or individual customers, etc., according to which purpose these statistics are to be used in the special case.

Besides this routine work that is by no means a trifle in an industrial works of the size and importance of an iron and steel works, there are the special investigations arising from the various inquiries from members of the management ; and this part of the work of the costing department can, of course, not be planned beforehand. The nature of the matter involves large fluctuations of the amount of work and it must be left to the skill of the manager of the costing department to dispose of the work at hand and possible suggestions which he himself may keep in reserve, in such a way that a fairly equal activity even for this part of his staff is achieved. If he succeeds in this direction and simultaneously is able to give the management the information he is asked for, correctly enough and in time, he has nothing to fear in regard to his position : his superiors will know how to estimate him and his colleagues will be grateful for the valuable help they receive from him.

CHAPTER XX

# THE ORGANISATION OF THE EFFICIENCY DEPARTMENT

## A. THE PROBLEM

When using for the moment the denotation " efficiency department " for the office the organisation of which will be the object of the following discussion, the author is well aware that this name is not only misleading, but—what is worse—wrong from a psychological point of view. As every employee has the duty to work as efficiently as possible and every departmental manager to develop the efficiency of his own department as highly as the working conditions allow, the denotation of a special department as " efficiency department " seems to imply that this duty has not been accomplished sufficiently and somebody has to be appointed to look into this matter and put it right. It may be that this impression disappears in the course of time, if the " efficiency department " is working in a correct and reasonable manner, but its introduction into works where it does not yet exist is at least made unnecessarily difficult and each newcomer to the firm has first to overcome a mistrust which is created by this wrong name. Actually what has been indicated before as the supposed purpose of this department is exactly what it should avoid in all circumstances. Where it is working satisfactorily it considers itself " a faithful servant " to all other departments helping them to increase their efficiency by carrying out special investigations for which these departments themselves have either no time in the course of their daily routine work or no specially trained persons for the investigations in question. Care should be taken that such investigations are made only on the suggestion of the works- or departmental-manager concerned, or if the proposal originates with the efficiency department all details affecting the running of the departments concerned must be discussed with their chiefs and the results of the investigation

first shown to them. In a word a faithful co-operation with the people whose work is to be investigated is the predominant and indispensable demand of a prosperous working of the "efficiency department."

The organisation of the efficiency department is not easy as the work at hand fluctuates so largely that planning beforehand is almost impossible. The department is in the position of a factory working solely on orders not into stock : if its customers, the other departments, do not suggest new investigations, and propositions made in this direction by the manager of the efficiency department based on his intimate knowledge of the working conditions of the firm are not accepted by the departments concerned, a lack of work may arise which can ultimately force the dismissal of trained staff members in the efficiency department, who are perhaps urgently needed a few weeks later when some change in design, production methods or organisation has brought about the necessity of new investigations. Again, the usefulness of a close co-operation with the other departments is obvious : if the manager of the efficiency department possesses the confidence of his colleagues and "customers" it will be easy to discuss with them the need for work, to find objects of investigations, which have perhaps been postponed as not so important during a time of high activity, and thus to help the efficiency department tide over a "dead time." We can say the difficulty in the efficiency department is almost opposite to that in the costing department : in the latter the amount of routine work is such that investigations of this or that problem can normally be inserted only with great disturbances ; in the former there is scarcely any routine work, but nearly exclusively special investigations, the number and extent of which depend largely on the goodwill of the other departments.

Another difficulty is founded on the kind and purpose of the investigations carried out by the efficiency department. As already mentioned, these are mainly work- and time-studies, and sometimes also organisation-studies. In any case, these investigations are carried out in order to find any improvement of the efficiency of the department concerned, an increase of output, a shortening of working times, a lowering of costs, etc. As long as they are strictly limited to figures of quantities or times there is no doubt that they are exclusively objects of the work of the efficiency

department. But in questions of economic working there always comes a moment when the transition to money-figures can no longer be avoided ; the actual comparison of costs begins and the domain of the costing department is affected. The question arises : who has to continue the investigation ? The man who has started it and is familiar with the whole course of what has been done already, but must be assisted now by the cost specialist? Or the man who needs information from the original investigator about the results to date but can then finish the work without further help ? It seems to be irrelevant what answer is given and if taken from a purely objective point of view that is certainly the case ; but in practice "departmental policy" plays its role in the decision and unfortunately very often an important one. It depends sometimes only on the question which of the two partners is the stronger personality or has a greater influence on the general manager or the managing director, so that his department remains "victor" in the struggle. That, of course, is a very unsatisfactory solution of the problem, but still a better one than an indefinite "muddling through," a decision from case to case with all the discussions and little quarrels always connected with such an uncertainty of competence, which must be considered as a clear symptom of bad organisation.

That may have been the reason for the solution given in the case of the organisation of an efficiency department in a South African iron and steel works which was published some years ago. As this description gives a very clear survey of the work which should be entrusted to an efficiency department and of the manner in which this work should be carried out, a summary of this description of some length may here follow, especially as such a description of a real case shows more vividly than any theoretical discussion the actual working of such an organisation.

However, before beginning this summary, let the name "efficiency department" be changed to something more apt. Analogous to the generally accepted expression "national economics" we may call it the "works-economics department" ; and just as a Ministry of Economics would supervise and control the nation's economic life, so this department if developed in the manner as characterised by the following example would fulfil the same function for the works in question.

## B. AN EXAMPLE OF THE ORGANISATION OF A WORKS-ECONOMICS DEPARTMENT

The iron and steel works in question, the South African Iron and Steel Industrial Corporation, Ltd. (Iscor.), is built up on a raw material basis in the possession of the company, and is composed of ore and dolomite mines, a coal-washery plant, coke ovens and a by-product plant, blast furnaces, a steel melting shop, a lime and dolomite burning plant, a cogging and finishing mill, a sheet mill, a foundry, and the necessary power station and auxiliary shops.

**1. The Duties of the Works-Economics Department.** The duties of the works-economics department had been fixed in the beginning by a written programme, and this has proved, in general, appropriate under the working conditions, so that it can to some extent be taken as a description of its actual work.

The position of the department in the organisation is characterised by the fact that it depends directly upon the man at the top and that it forms a connecting link between the individual shops mutually, and these shops and the management on the one hand, and the technical side of the works and the costing department on the other hand.

From this position the main duties result :—

(1) The works-economics department has a decisive word concerning the construction of the costing department, in order to avoid, from the beginning, the usual discrepancies which may arise from the different interests of the technical and commercial side of the undertaking on the results of the cost department. This construction has been built up in close connection with the works accountancy department, and it has been determined that future changes could be made only in close co-operation of both.

The works-economics department has further to take care of :—

(2) Construction and future development of the general works organisation.

(3) Time studies as assistance for production control, rate-fixing or costing purposes.

(4) The planning system from the costing as well as from the production point of view.

(5) The economics of material of any kind.

(6) Cost and production statistics.

(7) Special investigations of any kind believed to be desirable for the improvement of the economy of the undertaking.

All these duties are carried out on behalf of the managing director and general manager, and any demands of the individual departments must first be sanctioned by the management. Fuel department and test-house are separated sections, but work together with the works-economics department where necessary.

**2. The Organisation of the Works-Economics Department.** The staff of this department has intentionally been kept as low as possible. During the first two years of production it comprised the manager of the department, three specially trained engineers as assistants, and a secretary for administrative work and correspondence. Help was given, if necessary, for extensive investigations—*e.g.*, time studies on a plant composed of several machines—by persons borrowed from other departments, and by apprentices training for the position of production engineer.

It may seem to be incredible that such a small staff should be able to carry out the duties enumerated above ; but it should not be overlooked that it is not the job of the works-economics department to do the routine work covered by the seven headings given, but on behalf of the general manager, to determine how this work should be done, and to smooth out and settle difficulties which may arise.

Fundamental rules have been made to guide members of the staff of the works-economics department in carrying out this difficult and responsible job—*e.g.*, the manager of any department concerned in an investigation should be informed in advance about the kind and extent of this investigation, nothing should be done in his department during the investigation without his knowledge, and the final report should be discussed with him in detail, before it is issued to the general manager, etc.—but much must be left to the discretion of the staff members of the works-economics department, who should always bear in mind that, although working on behalf of the general manager, they are by no means superior to any member of the other departments, but have to create an atmosphere of confidence, so that these other departments work with them voluntarily and willingly.

Of the many details of organisation only a few may be mentioned which are of interest in this connection as they are either a confirmation or an extension of former explanations.

**3. Production Reports.** The daily and monthly production reports are built up to the various demands of production control and costing ; as far as it can possibly be arranged, the personal desires of the departmental manager in question have been taken into account, and uniformity is set aside, remembering that these reports should be designed to assist this manager and therefore are best adapted to his requirements. The reports are kept as short as possible, less in order to avoid unnecessary writing than to give an easier survey ; but care is taken that no important figures are omitted. These reports should give an analysis of production as well as of time. The time analysis should show the main, the supplementary, and the lost times, and must give the reasons for the last ones. It is then possible to range the sources of stoppages in the order of their importance and to try improvements where they promise the greatest success. The analysis of production is not only built up by absolute figures of tons, pieces, length, etc., but special care is taken that fluctuations due to the various qualities of material and products, and of dimensions, are eliminated as far as possible by the use of equivalent figures, so that fluctuations by different stoppages, varying intensity of labour, etc., can more easily be recognised. The results are compared with carefully elaborated standards, based mostly on time studies, and it is considered that a satisfactory result is attained only when the production measured by a suitable equivalent figure and referred to the actual working time, fluctuates but little against the standard production. A daily report of the number of men in the service of the company, either working or absent by illness or leave, and of their total working time distributed over the various shifts, is closely connected with the production report. Care is taken that working time on Sundays and holidays and other overtime can be clearly distinguished, and that all these figures are summarised weekly and monthly for statistical purposes.

**4. Organisation of the Internal Railway Traffic.** As a special and temporary task the organisation of the internal railway traffic was subordinated for some months to the manager of the works-economics department, as serious difficulties arose

soon after the starting of production; obviously, not sufficient precautions were taken to meet the demands not only of the proper production but also of the building of new shops and plants which continued during the initial period of production. The time table for arriving goods trains had to be established, the goods and materials distributed to the various destinations, and empty wagons returned quickly; additional rail tracks were necessary, defective tracks had to be repaired and maintained, wagons suitable for the various shops had to be bought and put into regular use, and a maintenance shop for locomotives and wagons laid out, built and started.

The works were divided into several sections and a representative of the traffic department had to take care in each section to ensure smooth operation of the traffic according to the information of arriving and outgoing consignments, given directly from stores and receivers. This close connection between the traffic and production proved very successful; especially was this obvious from the decline of demurrage for public locomotives and wagons.

As the traffic costs were unusually high in these works because of the terrassed estate, the costs control was carried out more extensively than is usual: a budget was made showing the standard of costs per locomotive hour, separated for steam and non-combustion engines, and of the number of locomotive hours of each section. As soon as the organisation was running smoothly the management of the traffic department was handed over to a special manager engaged in the meantime for this position.

**5. The Planning System.** It may be possible when considering the planning system to distinguish between three purposes of this arrangement, all these directed to the same aim, the raising of economy—*i.e.*, lowering the costs, increasing the output, and improving production methods.

The planning of costs had, of course, taken place before the decision to build the works, but it was repeated more in detail soon after starting production, and again a year later. The resulting costs statistics show throughout the actual costs in comparison with what they ought to be, not only for the whole works, but also for the individual departments and sections; the comparison of the running month with the previous one is

generally omitted as valueless because of the many contingencies which creep in; the reports are prepared on printed forms more or less in the arrangement of tables, and as much as possible are illustrated by graphs, prepared and completed month by month by the works-economics department. These papers, containing few but all important and necessary data, form the basis for monthly meetings, directed by the general manager. Care has been taken that all important changes of the figures are explained on these papers, and these explanations are prepared by the works-economics department in conjunction with the responsible production department, in order to avoid any reason of ill-feeling. The monthly meetings take place between the 15th and 18th of the following month, the period of 2 to 2½ weeks giving time enough for careful preparation of the meeting and providing a suitable limitation of their duration, while presenting figures new enough to enable discussions to have a practical value.

With the two other purposes of planning, increasing the output and improving production methods, we approach the wide sphere, where especially work and time studies are the expedients for progress. These problems have been dealt with so extensively that further additions are not necessary.

**6. The Form of Statistics.** The statistics of costs are, in the works in question, concerned with (*a*) total costs, (*b*) charge costs, (*c*) manufacturing costs, and (*d*) general overhead charges. The most important of these groups for the workshops is the third one, and this group is therefore mostly sub-divided. All data are given in the form of tables and graphs, and the trend of the figures is shown by recording the data for the months of the running year, one beside the other. As far as possible, the actual data are always compared with those assumed to be possible under present working conditions. The diagrams, showing the development of costs in graphical form, are not considered to be secret documents, but are posted up in the shops in question for continuous information and admonition of the departmental manager, his assistants, foremen and workmen.

The production statistics are closely connected with the cost statistics, but as they can be helpful for production only if they are built up according to the demands of production, they are often prepared in the offices of the shops, while the cost statistics are considered the duty of the costing department. This separation

leads to duplication of work and even to discrepancies of the figures given from both sides. That is avoided in the works in question by making the whole internal statistics one of the duties of the works-economics department, which is familiar with this kind of work, since it delivers a great part of the basic figures from its investigations, time studies, etc. The production statistics are divided into those of output and of times, and the degree of efficiency is expressed in some coefficients, which show how far it is possible to obtain the practical ideal or standard.

**7. The Wages and Bonus System.** As the Iscor Works were the first iron and steel works in South Africa, it was first necessary to build up fair basic wages for all classes of workmen. In the first year after starting production wages were paid on hourly rates, but later a bonus system was introduced, according to some principles which were the same for all departments and sections throughout the works. Only two of these principles may be mentioned; the bonus has been built up on equivalent figures (equivalent tons, equivalent pieces, equivalent lengths, etc.), which alone guarantee that the dangerous "good" and "bad" piece-work rates do not arise; the introduction of the bonus, in spite of the pressure from the productions departments, has always been postponed until some steadiness of production has been obtained, which made great fluctuations of the earnings of the men impossible. The careful and cautious introduction of the bonus system, without any major troubles by the workmen, can be considered as a great success of the works-economics department; it took many months before this important job was finished, and it is obvious that this problem needs continuous attention since any change in the plants, in production methods, or any other working conditions, may lead to a change of the basic figures of the bonus system.

So much about the manner in which the duties of the works-economics department were determined and carried out in the works, which have here been selected as an example. It may be repeated that it is only an example. It would be difficult, if not impossible, to repeat the scheme to full extent in other works; personal questions especially, as well as former development and tradition, may produce difficulties when introducing such an organisation in existing works; difficulties which, of course, have

been unknown in the case of a completely new undertaking. The reader, who may have drawn comparisons with the conditions under which he has to work, will have certainly found out these differences and should be careful to avoid the mistake of severely criticising something because it happens to be different, without considering the reasons why differences should occur.

CHAPTER XXI

# THE SOLUTION OF THE PROBLEM

THE question arises : is the foregoing example of the organisation of a works-economics department a real solution to the problem of how the work of economic control in an iron and steel works should be carried out ? In spite of the fact that at the time of the publication of the report, more than two years after the starting of actual production it was claimed to be a valuable success, it is the author's considered opinion that this solution cannot be recommended generally. There is contained in it a fundamental mistake which will only too easily produce difficulties in practice at least as soon as a change of persons occurs and a perhaps otherwise valuable personality does not like to be pressed into this scheme.

Economic control should be considered as a whole ; as already mentioned, three kinds of investigation are the pillars on which it is based :—

Organisation-studies,
Work- and time-studies, and
Costing-studies.

Nobody who has studied this book attentively can deny the intimate connection and interweaving of these studies. Why then give the care of these studies partly to one and partly to another department, thus creating "planes of friction" which do not exist in the work itself ?

The author's solution is an amalgamation of the costing department and the works-economics department into a unity, *a department of economic control.*

It has been shown that difficulties arise as long as the two departments exist one besides the other : the solution given in the South African example, the partial subordination of the one department under the other, in this case of the cost-department under the works-economics department smacks of " depart-

mental policy" and must therefore bear in itself at least the germs of difficulty, even if these may be overcome for some time by the influence of some strong personality. All that disappears if the unity, economic control, is represented in the organisation of the undertaking by a single department under uniform direction.

There will be more than enough routine work to keep the bulk of the employees busy for all the time, and as the special investigations which form an important part of the duty of the two departments are now unlimited in all three directions it will be easier to provide work for the specialists trained to carry out jobs which need an independent and understanding mind. It is not necessary to catalogue the jobs of work falling to the department of economic control; to do so would be merely to repeat what has been said about the separate duties of the two departments composing it, without, of course, those items concerned with their interrelation. Therefore it is sufficient for the reader to refer to Chapter XIX, (*d*) "Summary," and Chapter XX, (*b*) "An Example of the Organisation of a Works-Economics Department." There is only one point which should be repeated because of its overwhelming importance: what has been said about the relation of the two separated departments to other parts of the works, production, sales, main, supplementary, auxiliary or administrative departments, is and remains correct also for the united offices: the department of economic control can be of real use for the concern only if it considers itself as a service and avoids even the appearance of aspiring to any leading position in regard to other departments.

The author is well aware that this proposition will at first seem new and strange to the practical man. There will be opposition—what new measure of organisation did not meet with it?—but it is hoped that reflection will show this idea to be worthy of serious consideration.

Of the possible objections the strongest and most certain to be raised is the unfitness of the engineer from the works-economics department and the accountant from the cost office to run the new department, seeing that the engineer is inexperienced in costing as the accountant is in technical matters. In other words, the contrast between technical and administrative thought and methods, mentioned in the introduction of this book, is raised as a

bar against the logical and reasonable solution of the problem of organising economic control.

The author's answer will not surprise anyone who has carefully followed the argument of this book. It is that neither the pure technician nor the pure accountant is the correct leader of a department of economic control; rather it should be a man with the common sense, method and vision necessary to handle the technical, commercial, economic or psychological problems put before him in a way that promotes the success of the works as a whole. Whether this man comes from the technical, commercial or administrative side is of no consequence, provided that, in the words of that past master of scientific management, Fred W. Taylor, he is "the right man in the right place."

If he comes from the technical side he must have acquired during his practice a sufficient knowledge of the rules of accountancy and industrial administration; if he has been trained as an accountant he must have used his opportunities to make himself familiar enough with technical thinking; in both cases he must be a personality of such standing that he can easily afford to confess his ignorance of trifling professional details outside his own training without thereby losing a grain of his authority either to his colleagues or to his subordinates. The answer that such persons do not exist cannot be accepted; the history of industry shows too clearly the reverse. And if some lack of such persons is admitted it would be high time to create opportunities for training them. Nothing, however, would be better suited for this purpose than working in a department of economic control of such a structure as described in these pages.

Thus the ring is closed: the solution of the problem discussed in the introduction of this book has been found; the contrast in thinking between persons of different professional training, the most important hindrance of true co-operation within an industrial works, can be removed or at least softened into insignificance by the very medium which has to be considered as representative of the idea of economic control in the works.

# INDEX

The references in **bold type** are of special significance, mostly indicating definitions